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THE

VOYAGE OF H.M.S. CHALLENGER.

ZOOLOGY—VOL. V.

REPORT

ON THE

SCIENTIFIC RESULTS

OF THE

VOYAGE OF H.M.S. CHALLENGER

DURING THE YEARS 1873-76

UNDER THE COMMAND OF

CAPTAIN GEORGE S. NARES, R.N., F.R.S.

AND

CAPTAIN FRANK TOURLE THOMSON, R.N.

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PREPARED UNDER THE SUPERINTENDENCE OF

THE LATE

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AND NOW OF

JOHN MURRAY, F.R.S.E.

ONE OF THE NATURALISTS OF THE EXPEDITION

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CONTENTS.

I.—Report on the Ophiuroidea dredged by H.M.S. Challenger, during the years 1873–1876.

By Theodore Lyman.

(*Received August* 30, 1881.)

II.—Some points in the Anatomy of the Thylacine (*Thylacinus cynocephalus*), Cuscus (*Phalangista maculata*), and Phascogalé (*Phascogale calura*), collected by H.M.S. Challenger, during the years 1873–1876; with an account of the Comparative Anatomy of the Intrinsic Muscles and Nerves of the Mammalian Pes.

By Dr. D. J. Cunningham, Professor of Anatomy in the Royal College of Surgeons, Dublin.

(*Received March* 28, 1882.)

EDITORIAL NOTES.

THE Report which forms the first part of the present volume is, as Mr. Lyman says, a complete Monograph of the Ophiuridæ and Astrophytidæ.

As representatives of these two families, especially the former, were the animals most frequently obtained in our trawlings and dredgings, the examination and description of our large collections has been a most laborious undertaking.

The Memoir contains the description of twenty new genera, and one hundred and sixty-seven new species, together with a list of all known forms.

To these must be added another new genus and three new species, which, for reasons stated in the Postscript, did not reach Mr. Lyman till his Monograph was in type.

The late Editor was most fortunate in securing the co-operation of our American friends, Messrs. Lyman and Agassiz, in working out the Echinodermata of the Expedition. It remains for me to congratulate Mr. Lyman on the successful completion of this valuable contribution to Science.

In the lists of the Challenger Reports which have hitherto been published, the paper which forms the second part of this volume has been entitled, "Report on the Marsupialia," but this name does not correctly indicate its true character.

Shortly after the return of the Challenger to England, one or two scarce Marsupials were handed over to Dr. (now Professor) D. J. Cunningham for anatomical examination.

While engaged in the study of these species, Professor Cunningham found it necessary, so far as the foot was concerned, to push his inquiries into the Mammalia generally; and to assist him in this more extended investigation, a

considerable number of other Mammals, collected by the Challenger in various parts of the world, were placed at his disposal for dissection.

In this way what was originally intended to be limited to a Report on the Anatomy of a few rare Marsupials, now embraces in addition a valuable research on the Comparative Anatomy of the Mammalian foot.

These Reports form respectively Parts XIV. and XVI. of the Zoological series of Reports. Part XV. of this Series—Report on the Actiniaria of the Expedition, by Professor Richard Hertwig—will appear in the next Zoological volume.

JOHN MURRAY.

THE

VOYAGE OF H.M.S. CHALLENGER.

ZOOLOGY.

REPORT on the OPHIUROIDEA dredged by H.M.S. Challenger during the years 1873–76. By THEODORE LYMAN.

INTRODUCTION.

THIS monograph attempts to describe and classify the OPHIURIDÆ, or Brittle-Stars, and the ASTROPHYTIDÆ, or Branching-Stars, collected during the cruise of the Challenger. Seeing that the twenty new genera and the one hundred and sixty-seven new species formed a large proportion of those known, and considering that there were also collected not a few of the old species, I deemed it wise to add the names of all others previously described, and to arrange them under their genera with proper references and explanations. Thus, by the addition of a few pages, the work has become a handbook of the two families treated of.

First comes the descriptive portion, wherein are given descriptions of the new Ophiuridæ arranged in their three groups, and of the Astrophytidæ, both branching and simple-armed. There are added, from time to time, such anatomical observations as I have been able to make. Then follow tables of distribution, geographical, bathymetrical, and thermal, with brief reflections on their indications. At the end is a note on fossil species and their relations to those living.

The anatomical parts spoken of are explained by frequent references to the plates. Should the reader need more detailed information, he will find it in my Ophiuridæ and Astrophytidæ Old and New,[1] or in Dr Ludwig's Morphologische Studien an Echinodermen.[2] In order to understand a description, it is necessary to bear in mind that the animal is supposed to have the mouth below; then vertically, towards the roof of the

[1] Bulletin of the Museum of Comparative Zoology, vol. iii., part 10, pp. 254 and 260.

[2] Zeitschr. f. Wissenschaftl. Zoologie, vol. xxxi., 1878, p. 241; vol. xxxiv., 1880, pp. 1 and 57.

disk, is "upwards;" towards the mouth, "downwards;" horizontally, towards the points of the arms, "outwards;" and horizontally, towards the mouth, "inwards."

Some readers may take it amiss that I have omitted to present any tree-like diagrams, setting forth the descent of these two families from others of the animal kingdom. I am not unaware that distinguished naturalists have formed a sort of zoological herald's college, whence have emanated a great number of genealogical trees, intended to show the exact descent and relationship of certain animals. These pedigrees would be most useful, were it not for the absence of some thousands of essential ancestors whose whereabouts is unknown, or even unknowable. Feeling quite unable to say what are the precise relationships among Brittle-stars, I have, nevertheless, tried to place the genera in such order, and to give such notes on them, as would show their resemblances and their differences. To push the statement further seems, in the present state of knowledge, unprofitable. It is the less important to be precise, because the several theories of evolution which more or less depend on such genealogical trees, or pedigrees, have an interest almost wholly historical, and hardly at all philosophical. That is to say, they treat of the sequence of facts and not of their reason.

So far as philosophy is concerned, all the excitement of our day over these theories is uncalled for. There prevails, indeed, a vague impression that they explain something, whereas they explain nothing. They only assert, more or less dogmatically, that certain events happened, in a certain order; just as there used to be a theory that the leaning tower of Pisa was built leaning. There also was a theory that it was built straight, and that it settled afterwards. Neither explained the tower, and both assumed that masons built it; but one asserted that the courses were laid slanting, the other that they were laid horizontally.

Theories of evolution, considered from their legitimate stand-point (viz., the historical), have always this trouble, they make their machine do more than it can do. Their auger goes on boring round holes till the opportune moment, and then suddenly it bores a square hole. For example, the best research goes to demonstrate that there can be no vital growth without an egg, or a seed, at the first stage. Air filtered or strongly heated produces no life. Now, it is agreed that the earth was once too hot to permit organic material. Whence, therefore, came the first egg, seed, or germ? Several attempts have been made by evolutionists to jump this insurmountable fence. One has suggested that the first germ came from a fortuitous collection of atoms; but in positive science nothing is fortuitous, and neither in physics nor in metaphysics is such a thing as an atom provable.

The so-called theory of separate or special creation has, in like manner, an interest purely historical. There is as much special creation in evolution as in any other history of growth and no more. The moment a type varies, there must be special

creation. If a certain egg grows into a plover with three toes it is a "Beetlehead," which must continue to produce Beetleheads; but let a rudimentary hindtoe be added and there results a "Blackbelly"; and this is special creation. Every physiologist knows that the observed permanent addition of a hindtoe in an embyro would be an event in embryology comparable to the French revolution in politics.

We hear much of "laws" of nature and of their "immutability." Our only idea of immutability is absolute sameness, and absolute sameness would be nature in everlasting rest. Definition so exact is, however, not needed to show that the laws of nature are far from immutable. Such laws are known only by their results; and these results show, on every side, clashing, disorder and interference. There are millions upon millions of tendencies which are checked, warped, or destroyed by other millions. Animal nature preys on itself and on vegetable nature, and vegetable on animal. Nor is this work of destruction and recomposition a regular and compensating one. Sometimes there is compensation and balance; but again there may be annihilation of certain forms. Astronomy, with its noble formulæ, is really no better off. Its accuracy is only comparative, as concerning vast times and spaces. It is not possible to say that the earth has an absolute orbit, when we consider that the planet has irregular lumps, four miles high, on its sides, and that its path is affected by every petty meteor that approaches. In reply it may be said, that, behind this disorder, there stands an eternal order which corresponds to the higher conceptions of the human mind. I do not deny it; but such eternal order is a matter of faith, an ideal. The phenomena within our reach exhibit only enough order and law to prevent them from falling into chaos. In like manner human law has an ideal, but the observed results would not prove its existence. All we notice in communities is a tendency to law, which is feeble or strong according to the degree of their civilisation.

It is said that zoological forms are matter evolved under immutable laws, but these laws so far from being constant, are subject to perversion and interference. As for matter, it is introduced as the matrix of all properties, which properties may be latent, that is, hidden from our view, or active, and therefore observable. Matter itself is in its last analysis everywhere the same; from which it follows that the smallest division of matter contains all the properties, or, as they are called, potentialities, that are held by the universe. Each atom, or molecule, or cell, is cosmos in itself. Example: among the cells that form the human body, and whose number is so vast that no idea of it could be conveyed by figures, there appears one cell, microscopic in size, simple so far as we know simplicity, having no exceptional relations to light, heat, or electricity, showing no sign that foretells a peculiar career. It is a female cell, an egg. Among another collection of cells there appears, in like manner, a cell; that of the male, a spermatozoon. So long as they stay apart, each runs the common course of an organic element, ending in dissolution and in passing into the waste material of the general mass. But, when

the two come together, there is a different result. The male cell apparently is absorbed and disappears in that of the female;—apparently only, for the result is neither male nor female, but neuter; and, as a neuter, it takes on the power of growth in a specific direction. Regardless of everything save actual violence, this soft and tiny germ keeps steadily on its course. Sheltered from the awful powers of nature; never warped by the environment of myriads of growing shapes, it moulds itself in imitation of a body it cannot see; and, when that imitation is complete, it stops,—now no longer a neuter, but a male or a female and ready to begin its course of reproduction, decline, and death. What is a plain statement of this process? It is, that two cells, neither of which had at the outset any suggestive character, combine; and then reproduce the complex organism from which they sprung. Here is man, who properly is called a little world, produced from a cell. The only organic connection between father and child is a cell, a spermatozoon; and yet we see children taking absolutely after the father in physical structure and in mind. The only connection between grandfather and grandchild is a single cell from among thousands of millions of cells, which thousands of millions were, many years before, influenced in their growth by a single cell from that grandparent. And yet, again, we see children having no likeness to their father but evidently taking after their grandfather.

If, however, a cell (spermatozoon) can determine the structure of a grandchild, we have this dilemma:—(1) Each cell carries potentiality to do anything. (2) Many millions of cells may be ruled by one of their number, which is no better than they. Or, to speak more generally, if each cell contains in itself power for every development (as by the theory of development it must, because all forms are evolved, one out of another, and what we call species are but temporary halts in evolution), then such cell is by itself really more powerful than in combination with others; for, as soon as it combines with others, most of its powers become latent, and only such of them remain active as are employed in building the structure intended—for example, a Beetlehead plover. From this it follows:—(1) That organised matter attains its greatest power in its smallest size and in a solitary state. (2) That the living kingdoms being made up of a quasi-infinite number of such smallest organised units of matter;—of cells, to wit,—each cell is all-powerful, and of course equally potent with every other cell. (3) That these all-powerful and equal cells agree to make combinations, and thereupon cease to be all-powerful and become, for the time being, limited in power.

The history of a cell has been given above, and it is only a history: a bare statement of the development, or evolution, of certain matter under given conditions. Hence it follows that all theories of growth, development, or evolution, have simply an historical interest, and very little philosophical. Every human being has grown from two cells, and that growth is nourished by the same material that nourishes the growth of other

animals. In the course of his development, he passes from mere organised tissue to an embryonic form, and thence to the stage of a new-born animal—living free, yet devoid of intelligence and incapable of locomotion. He takes many months to get beyond the mental capacity of a dog, and twenty years to arrive at his full powers. The growth of his body is nothing more than an accumulation of material under a special form; and it makes no difference, philosophically, whether this accumulation has always followed its present order, or has formerly followed a different order. In the first case we must suppose the growth of Man always to have been what it now is; in the second case we must suppose him originally developed from one of the lower animals. To state it in a different form, we may suppose that two primitive cells have always grown into a man; or else that they, for a long time, grew only as far as one of the lower animals, but at length pushed on and attained the structure of man. Take what view we will, we are always talking of identical material, and of its building up, tumbling down, and rebuilding, just as a mason, having bricks and mortar, may build a house, or a tower, or a house surmounted by a tower. Whatever he builds he has but bricks and mortar, and his mode of using them is only a history—the history of his construction.

If, then, we know laws only in the form of tendencies, and matter only as a contradiction, we ought to be modest in our assertions about the order of nature. In other words, while we may amuse ourselves by arranging a procession of species, we must be prepared to see the pageant fall into confusion at any moment.

In the descriptive part of this monograph I have tried to use simple words as often as possible; and not to add to the jargon in which zoology is now smothering. In addition to a gigantic classification, to form which the dead languages have been torn up and recomposed, there is an ever-growing crop of anatomical and embryological terms. No callow *privat docent* but thinks he does good service in adding a score of obscure words, to define his ephemeral theory. Doubtless he is not aware that his work has two faces. First, as it regards himself, these new words of his have become familiar and convenient in a subject he has long studied. Secondly, as it regards his readers, not only have they never heard the new words, but have perhaps known the parts referred to by other names. They must, therefore, go through three painful processes:—(*a*) Commit to memory, with dreary labour, like sawdust-swallowing, the novel words. (*b*) Learn to what parts they apply. (*c*) Carefully forget the old terms.

The result of this system has been, not a language but a jargon such as Molière would scarcely have ventured to put in the mouths of the medical faculty in his Malade Imaginaire.

The ground trouble is in the notion, prevalent among scholars, that strict consistency and interdependence of words are of vast importance and to be attained *coute qui coute;* whereas they are of very slender importance and worth no sacrifice at all. What should

be aimed at is the understanding of things, and their description in words few and familiar. Confusion does not arise from employing the same word in various ways provided the context be well written. Does anybody fall into doubt about a yard, a back-yard, a steel-yard, a yard-arm, a whin-yard, or a vine-yard? A word changes meaning with each new combination, or surrounding, or tone. No one mistakes the sarcasm of, "You're a pretty fellow!" or the tenderness of, "What a pretty child!"

DESCRIPTION OF SPECIES.

Family, OPHIURIDÆ.

The Ophiuridæ are a family in the order of Starfishes characterised by a more or less sharply-defined central disk containing a simple digestive cavity which does not radiate into the slender rounded arms, and has no anal opening. The arms have an axis composed of jointed vertebra-like sections (arm bones), each made up of two ambulacral pieces soldered side by side. The axis is cased with plates, of which the single row, covering the under side, is peculiar. The plates on the sides bear spines. Each arm bone is pierced by a water tube, destitute of a bulb, and supplying the imperforate tentacle which is bedded in the bone itself. The halves of the first two arm bones are swung laterally, into the interbrachial space and soldered together to form the mouth angle,[1] and in them are set the mouth tentacles which are watered by a forking tube from the mouth ring. On either side of the base of each arm, above and below, run two stout pieces, the radial shield and genital plate, which are joined at the margin of the disk and connected by an adductor muscle. In the lower interbrachial space, parallel with and close to each arm, are one or two genital openings that enter a peculiar sac, the genital bursa, with which communicate spermatic or ovarial tubes. The inner angle of each lower interbrachial space is occupied by a single plate, the mouth shield, and one of these serves as the madreporic body.[2]

[1] Dr Ludwig considers the peristomial plate lying above the mouth angle as the junction of the first two ambulacral pieces, a view I hesitate to adopt, since this plate is in no way connected with either of the mouth tentacles, and because it may be composed of one, two, or three pieces, or be wanting altogether.

[2] For an epitome of the finer anatomy of Ophiuridæ, see P. H. Carpenter, the Minute Anatomy of Brachiate Echinoderms, Quart. Journ. of Micros. Soc., April 1881, p. 169.

For the bibliography of the two families, see T. Lyman, Ill. Cat. Mus. Comp. Zool., No. i., 1865, p. 5; No. vi. p. 5, 1871. H. Ludwig, Echinodermen des Mittlemeeres, Mittheilungen des Zoologischen Station zu Neapel, vol. i., No. 4, 1879.

For description and comparative nomenclature of the hard parts see T. Lyman, Bull. Mus. Comp. Zool., vol. iii., part 10, 1874, p. 260, pl. i.

GROUP I.—Arm spines on outer edges of side arm plates and parallel to arm.

Ophiura.

Ophiura, Lmk., Syst. Anim. sans Vert., 1801 (*non* Fbs., *nec.* Ltk.).

Disk granulated. Teeth, and numerous, even, close-set mouth papillæ; no tooth papillæ; spines essentially smooth, shorter than the arm joints, flattened, numerous (7–13); two tentacle scales, the upper one covering the base of the lowest arm-spine; an indentation in the back of the disk, where it is joined by the arm; four genital openings, the first pair beginning outside the mouth shields.

The disk scales, usually even and rather fine, more or less cover the small, oblong, separated radial shields, which are jointed to curved, rounded, club-headed genital plates, which are continued, by a ridge or thin plate, to the mouth shield. At the outer end of the genital plate is attached the genital scale, which is also continued, by a broken ridge or thin plate, to the mouth shield. The strong, compact, mouth angles are partly covered above by three peristomial plates, two forming an angle which is filled by the third. The arm bones are of a high type, being short and discoid, wider than high, and having the structural points of their outer and inner faces perfectly developed. (See Pl. XXXVII. figs. 1–3.)

A large *Ophiura*, supposed to be *Ophiura elaps*, Ltk., dredged in 120 fathoms by the U. S. steamer "Blake," proved, on making a section, to be a male (Pl. XLVI. fig. 3). There was a large bursa (*bu*) whose thin lining membrane (*bu'*) passed upward to the top of the arm, to whose middle line it was attached, thus limiting the sac on that side. On its upper surface it was attached to a part of the interbrachial floor of the digestive cavity (*st*) whose roof adhered closely to that of the disk, and was there smooth, while its floor was deeply folded, and descended into the interbrachial spaces, where it was attached to the disk-wall. The spermaries (δ) hung in a sort of festoon, their upper lobes, seen cut through at δ', being packed into the upper margin of the disk, near the adductor muscle (*rm*).

Table of Species of *Ophiura*.

(The granular covering on the radial shields and side mouth shields varies somewhat.)

Arm Spines equal.

Side mouth shields covered.

- Disk thick, with large grains. 8–10 wide and short arm spines. Mouth-shields wider than long, ... → *Ophiura brevicauda.*
- Upper arm plates broken in numerous pieces. 9–10 slender arm spines, as long as a side arm plate, ... → *Ophiura guttata.*

Side mouth shields naked.

- Mouth shields ovoid in outline. 7–8 slender, spaced, arm spines nearly as long as side arm plate, ... → *Ophiura brevispina.*
- Similar to preceding, but with longer arm spines, . . . → *Ophiura variegata.*
- Large (disk 19 mm.), with thicker arms and disk than in the two preceding, ... → *Ophiura holmesi.*
- Arms slender and tapering. 8–9 slender tapering, rounded arm spines, . → *Ophiura januarii.*

Lowest Arm Spines longest.

With naked radial shields.

- These two species, similar when adult, are quite different when young. Then *Ophiura lævis* has no radial shields, or very small ones; while *Ophiura cinerea* has them large and oval, ... → *Ophiura lævis.* / *Ophiura cinerea.*
- Upper arm plates divided symmetrically into a number of scales, . → *Ophiura squamosissima.*
- Upper arm plates broken. Numerous small naked swollen plates midst granulation of disk, ... → *Ophiura wahlbergii.*
- Upper arm plates entire. Mouth shields large. Side mouth shields naked, ... → *Ophiura rubicunda.*
- Upper arm plates entire. Large radial shields. Side mouth shields granulated, ... → *Ophiura panamensis.*
- Upper arm plates broken. Radial shields often wholly or partly granulated. Side mouth shields granulated, ... → *Ophiura teres.*
- Radial shields partly covered. Under arm plates with a re-entering curve without, ... → *Ophiura daniana.*

Radial shields covered.

- Medium size (disk 16 mm.). Mouth shields wider than long. 8–9 arm spines, ... → *Ophiura appressa.*
- Large (disk 30 mm.). 7–8 broad, close-set arm spines, . . . → *Ophiura elaps.*
- Similar to *Ophiura appressa*, but occasionally with naked radial shields, . → *Ophiura tongana.*

Ophiura brevispina, Say, Journ. Phil. Acad., vol. v., 1825, p. 149; Lym., Proc. Bost. Soc. Nat. Hist., vol. vii. p. 258, Jan. 1860; Ill. Cat. Mus. Comp. Zool., No. i. p. 18.

Ophioderma olivaceum, Ayres, Proc. Bost. Soc. Nat. Hist., vol. iv. p. 134, 1852.
Ophioderma serpens, Ltk., Vid. Meddel., Jan. 1856, p. 7; Addit. ad Hist., part 2, p. 96.
Ophiura olivacea, Lym., Ill. Cat. Mus. Comp. Zool., No. i. p. 23.

Off Bahia, Brazil.

Ophiura cinerea, Lym., Ill. Cat. Mus. Comp. Zool., No. i. p. 27, 1865.

Ophioderma cinereum, Müll & Tr., Syst. Ast., p. 87, 1842.
Ophioderma antillarum, Ltk., Vid. Meddel., p. 9, 1856; Addit. ad Hist., part 2, p. 88, 1859.

Bahia, Brazil; 7 to 20 fathoms.

Ophiura appressa, Say, Journ. Phil. Acad., vol. v. p. 151, 1825; Lym., Ill. Cat. Mus. Comp. Zool., No. i. p. 34.

Ophioderma virescens, Ltk., Vid. Meddel., Jan. 1856, p. 6; Addit. ad Hist., part 2, p. 92, pl. i. fig. 4.

Off Bahia, Brazil.

Ophiura tongana, Lym.

Ophioderma tongana, Ltk., Oph. Nov. Des., Vid. Selsk. Forh., p. 106, 1872,

Simon's Bay, Cape of Good Hope; 10 to 20 fathoms.

Species of *Ophiura* not herein described.

Ophiura brevicauda, Lym., Ill. Cat. Mus. Comp. Zool., No. i. p. 16, 1865.

Ophioderma brevicauda, Ltk., Vid. Meddel., Jan. 1856, p. 8; Addit. ad Hist., part 2, p. 94, pl. i. fig. 3.

West Indies; 1 to 35 fathoms.

Ophiura guttata, Lym., Ill. Cat. Mus. Comp. Zool., No. i. p. 10, 1865.

Ophioderma guttata, Ltk., Addit. ad Hist., part 2, p. 95, pl. i. fig. 8, 1859.

West Indies; 1 to 10 fathoms.

Ophiura holmesi, Lym., Proc. Bost. Soc. N. H., vol. vii. p. 255, 1860; Ill. Cat. Mus. Comp. Zool., No. i. p. 21, pl. i. fig. 7.

Charleston, S. C.

Ophiura daniana, Vll., Trans. Conn. Acad., vol. i., part 2, p. 254, 1867.

La Union, San Salvador; 7 fathoms.

Ophiura januarii, Lym., Ill. Cat. Mus. Comp. Zool., No. i. p. 25, 1865.

Ophioderma Januarii, Ltk., Vid. Meddel., Jan. 1856, p. 7; Addit. ad Hist., part 2, p. 97, pl. i. fig. 5, 1859.

Rio Janeiro.

Ophiura variegata, Lym., Ill. Cat. Mus. Comp. Zool., No. i. p. 10, 1865; Vll., Trans. Conn. Acad., vol. i., part 2, p. 254.

Ophioderma variegata, Ltk., Vid. Meddel., March 1856, p. 21; Addit. ad Hist., part 2, p. 97, 1859.

West Coast of Central America; 5 fathoms.

Ophiura lævis, Lym., Ill. Cat. Mus. Comp. Zool., No. i. p. 26, 1865.

Stella lævis, Rondelet, De Pisc., 1554, p. 120.
(?) *Stella lumbricalis longicauda*, Linck., De Stell. Mar., p. 47, tab. xi. fig. 17, 1733.
Ophiura lacertosa, Lmk., Syst. Anim. sans Vert., p. 351, 1801.
Asterias Ophiura, Delle Chiaje, Mem., vol. ii. p. 369, tab. xx. fig. 1.
Ophiure lezardelle, Blainv., Faune Franç. Stell., pl. vi.
Ophioderma longicauda, Müll & Tr., Syst. Ast., p. 86, 1842; Ludwig, Echin. des Mittelmeeres, p. 545.

Mediterranean.

Ophiura wahlbergii, Lym., Ill. Cat. Mus. Comp. Zool., No. i. p. 10, 1865.

Ophioderma Wahlbergii, Müll & Tr., Syst. Ast., p. 87, 1842.

Port Natal, South Africa.

Ophiura rubicunda, Lym., Ill. Cat. Mus. Comp. Zool., No. i. p. 30, 1865.

Ophioderma rubicunda, Ltk., Vid. Meddel., Jan. 1856, p. 8; Addit. ad Hist., part 2, p. 90, pl. i. fig. 2.

West Indies.

Ophiura panamensis, Lym., Ill. Cat. Mus. Comp. Zool., No. i. p. 32, 1865; Vll., Trans. Conn. Acad., vol. i., part 2, p. 253.

Ophioderma panamensis, Ltk., Addit. ad Hist., part 2, p. 91, 1859.

West Coast of Central America; Lower California.

Ophiura squamosissima, Lym., Ill. Cat. Mus. Comp. Zool., No. i. p. 10, 1865.

Ophioderma squamosissima, Ltk., Vid. Meddel., Jan. 1856, p. 8; Addit. ad Hist., part 2, p. 92, pl. i. fig. 7, 1859.

West Indies.

Ophiura teres, Lym., Proc. Bost. Soc. N. H., vol. vii. pp. 198 and 257, 1860; Ill. Cat. Mus. Comp. Zool., No. i. p. 37, fig. 1; VII., Trans. Conn. Acad., vol. i., part 2, p. 253.

West Coast of Central America; Lower California.

Ophiura elaps, Lym. (Pl. XXXVII. figs. 1–3, Pl. XLVI. fig. 3).

Ophioderma Elaps, Ltk., Vid. Meddel., Jan. 1856, p. 19; Addit. ad Hist., part 2, p. 93, 1859.
Ophiura elaps, Lym., Ill. Cat. Mus. Comp. Zool., No. i. p. 10, 1865.

West Indies; 120 fathoms. (Same species ?.)

Ophiopeza.

Ophiopeza, Pet., Monatsb. König. Akad., Berlin, 1851.

Disk granulated. Teeth, and numerous even, close-set mouth papillæ; no tooth papillæ. Spines smooth, shorter than the arm joints, flattened, numerous (5–10). Tentacle scales one or two; in the latter case the upper one covers the base of the lowest arm spine. An indentation in the back of the disk, at the base of each arm. Two genital openings in each interbrachial space.

In its general features, the skeleton is similar to that of *Ophiura*. The genital plates, however, are shorter and thicker, and the genital scale is attached at a point considerably inside the head, thus shortening the genital opening. On the inner face of an arm bone the umbo and articulating knobs are larger and more rounded. (See Pl. XLI. figs. 1–3.)

TABLE OF SPECIES OF *Ophiopeza.*

5–6 arm spines.	Radial shields naked.	18 disk grains in the length of 1 mm.	5–6 arm spines,	*Ophiopeza petersi.*
	Radial shields granulated.	13 disk grains in the length of 1 mm.	5 spaced unequal arm spines,	*Ophiopeza yoldii.*
		25 disk grains in the length of 1 mm.	6 arm spines. Mouth angle wholly granulated. Only one tentacle scale,	*Ophiopeza aster.*
8–10 arm spines.	Radial shields granulated.	25 disk grains in the length of 1 mm.	8 arm spines,	*Ophiopeza fallax.*
		13 disk grains in the length of 1 mm.	10 arm spines, equal, except the lowest,	*Ophiopeza æqualis.*

Ophiopeza yoldii (?), Ltk., Vid. Meddel., Jan. 1856, p. 9; Addit. ad Hist., part 2, p. 98, 1859; Lym., Bull. Mus. Comp. Zool., vol. iii., part 10, p. 221.

Ophiopsammus Yoldii, Ltk., Addit. ad Hist., part 3, p. 98, 1869.

Station 163.—April 4, 1874; off Twofold Bay; lat. 36° 56′ S., long. 150° 30′ E.; 120 fathoms; red clay.

Ophiopeza aster, Lym. (Pl. XXI. figs. 16–18).

Ophiopeza aster, Lym., Bull. Mus. Comp. Zool., vol. vi., pt. 2, p. 50, pl. xiv. figs. 395–397, 1877.

Disk densely and finely granulated above and below, including the mouth angle.

(Type specimen from Station 142.) Diameter of disk 11 mm.; length of arm 33 mm. Width of arm close to disk, 2 mm. Teeth narrow, sharp, and lanceolate; the two lowest usually split in two. The apex is occupied by a bunch of three or four short, crowded, spiniform tooth papillæ; and on each side of the mouth angle is a close line of small mouth papillæ whereof the inner ones are bead-like, while the two outermost are wider and somewhat flattened. The small, rounded mouth shields and the side mouth shields are completely covered by a close granulation. First under arm plate about half as large as those beyond, of a heart shape, with the point inward; the rest are rather small, somewhat broader than long, much wider without than within, having the outer side curved, lateral sides re-enteringly curved and a truncated angle within. Side arm plates small, clinging close to arm, widely separated above, nearly meeting below. Upper arm plates four sided, twice as broad as long, much wider without than within, with outer side gently curved and laterals straight. Disk pentagonal, flat, densely and uniformly covered with an extremely fine granulation, 20 or 25 grains in the length of 1 mm.; this granulation extends over the entire mouth angle quite to the bases of the mouth papillæ. Six very short arm spines, growing longer from above downward; the upper ones are rounded and peg-like; the lowest ones somewhat flattened, and scarcely more than half as long as a joint. One oval tentacle scale. Colour in alcohol, light greenish grey.

Station 142.—December 18, 1873; lat. 35° 4′ S., long. 18° 37′ E.; 150 fathoms; sand.

Ophiopeza æqualis, Lym. (Pl. XXVII. figs. 7–9).

Ophiopeza æqualis, Lym., Anniv. Mem. Bost. Soc. Nat. Hist., Nov. 1880, pl. ii. figs. 23–25.

Disk uniformly covered, including radial shields, by a close granulation. Ten flat crowded arm spines nearly equal, except the lowest, which is larger.

(Type specimen from Station 219.) Diameter of disk 25 mm. Length of arm about 150 mm.; width of same, close to disk, without spines, 5 mm. Fourteen to seventeen flattened, crowded mouth papillæ to each angle; those within small and pointed; the two outermost on either side much the broadest. Mouth shield short, rounded, heart-shaped, with a blunt angle inward. Length to breadth, 4 : 4. Side mouth shields very small,

occupying the outer lateral corners of the mouth shield. Under arm plates wider than long, with a rounded, truncated angle within; slight re-entering curves on the lateral sides and the outer edge curved. Side arm plates short and thick, with cleanly curved outer margin; separated above by the large upper arm plates which are much broader than long, and strongly arched with outer side straight, except at the corners where it is rounded; length to breadth, 4·5 : 1·3. Disk thick but flat, with a notch over the arms; it is covered, including radial shields and space next mouth papillæ, with an even, fine granulation; thirteen grains in 1 mm. long. Genital openings long, extending from outer edge of mouth shield nearly to margin of disk. Ten short, flat arm spines with rounded ends, about two-thirds as long as a side arm plate, except the lowest which is longer and larger. Two small, round tentacle scales, whereof one covers the base of the lowest arm spine. Colour in alcohol, nearly white.

Station 219.—March 10, 1875; north-east of New Guinea; lat. 1° 50′ S., long. 146° 42′ E.; 150 fathoms; mud.

This species agrees in the number of disk grains with *Ophiopeza yoldii*, but has twice as many arm spines. *Ophiopeza fallax*, and *Ophiopeza aster* agree with each other as to grains (about twenty-five in the length of 1 mm.) *Ophiopeza aster*, however, has six arm spines, instead of eight, and the entire mouth angle, including mouth shield, is closely granulated. Finally, *Ophiopeza petersi* has about eighteen grains in the length of 1 mm., six arm spines, and naked radial shields.

Species of *Ophiopeza* not herein described.

Ophiopeza fallax, Pet. (Pl. XLI. figs. 1–3).

Ophiopeza fallax, Pet., Monatsb. König. Akad. Berlin, p. 465, 1851; Wiegmann's Archiv, p. 84, 1852.

Great Ocean.

Ophiopeza petersi, Lym., Bull. Mus. Comp. Zool., vol. v., part 9, p. 217, pl. ii. figs. 22–24, 1878.

West Indies; 177 fathoms.

Pectinura.

Pectinura, Fbs., Linn. Trans., vol. xix., 1842.

Disk granulated. Teeth, and numerous even, close-set mouth papillæ; no tooth papillæ. Spines smooth, shorter than the arm joints, numerous (5–15). Tentacle scales, rarely one, usually two, in which case the upper one overlaps the base of the lowest arm spine. An indentation in the back of the disk at the base of each arm. A supplementary

plate just outside the true mouth shield. Two genital openings in each interbrachial space. *Pectinura* is separated from *Ophiopeza* only by having a supplementary plate outside the mouth shield; and both are distinguished from *Ophiura* by the minor anatomical character in this last, that, by a partial adhesion of the edges of the genital openings, each one is divided into two. The similarity actually found in the skeletons would be expected. In all three the disk is enclosed by a coat of stout imbricated scales and strong radial shields. The genital plates, thick and rather wide, are attached to short, stout genital scales, which, in *Ophiopeza* and *Pectinura* are articulated farther inward, thus shortening the genital opening. The mouth frames and jaws are strong and finely curved and bear three thick peristomial pieces whereof two form an angle, whose opening outward is wedged by the third. The arm bones are of a high type, having thin wings, and the umbo, articulating peg and other subordinate parts well marked.

TABLE OF SPECIES OF *Pectinura*.

Disk covered, under its granulation, with coarse scales or swollen plates.	No pores between under arm plates,	Radial shields granulated. 13–15 arm spines,	*Pectinura spinosa.*
		Radial shields granulated. 9 short arm spines,	*Pectinura arenosa.*
		Radial shields naked; also some other disk plates. 9 arm spines,	*Pectinura infernalis.*
		Radial shields naked. 3 arm spines,	*Pectinura heros.*
	Pores between first and second under arm plates,	Arms cylindrical at their insertion in the disk, which is puffed,	*Pectinura gorgonia.*
		Arms widened at their insertion in the disk, which is flat, 10–11 arm spines,	*Pectinura marmorata.*
		Arms widened at their insertion in the disk, which is flat, 5–6 arm spines,	*Pectinura stellata.*
Disk, under its granulation, covered with minute and smooth scales.	Ten thin equal arm spines; under arm plates encroached on by side arm plates,		*Pectinura vestita.*
	Pores only between first and second under arm plates,		*Pectinura maculata.*
	Pores between the under arm plates continued for some distance along the arm,	7–8 conical arm spines, the lowest one a little the longest,	*Pectinura septemspinosa.*
		8–9 flat, pointed arm spines, the lowest one very long and flat, often equal to two joints in length,	*Pectinura rigida.*
	Of doubtful place,		*Pectinura verrucosa.*

Pectinura gorgonia, Ltk., Addit. ad Hist., part 3, p. 33, 1869.

Ophiarachna gorgonia, Müll. & Tr., Syst. Ast., p. 105, 1842.

Fiji Islands.

Pectinura maculata, Vll., Proc. Bost. Soc. Nat. Hist., vol. xii. p. 388, 1869; Lym., Bull. Mus. Comp. Zool., vol. ii., part 10, p. 222; Vll., Amer. Journ. Sci., vol. xlviii., 2nd series, p. 431, 1869.

(?) *Ophiura maculata*, Hutt., Ech. New Zealand, p. 3, 1872.

Queen Charlotte's Sound, New Zealand; 10 fathoms.

Pectinura rigida, Lym., Bull. Mus. Comp. Zool., vol. iii., part 10, p. 224, 1874.

(?) *Ophiura cylindrica*, Hutt., Echin. New Zealand, p. 3, 1872.

Fiji Islands.

Pectinura stellata, Ltk., Addit. ad Hist., part 3, p. 33, 1869; Lym., Bull. Mus. Comp. Zool., vol. iii., part 10, p. 221.

Ophiarachna stellata, Ljn., Oph. Viv. Öf. Kong. Akad., p. 305, 1866.
Ophiochasma (*Ophiolepis*) *adspersum*, Grube, Jahres Bericht. d. Schles. Gesell., p. 23, 1867.
Ophiarachnella stellata, Ljn., Dr. Goës, Oph. Öf. Kong. Akad., p. 640, 1871.

Station 208.—January 17, 1875; lat. 11° 37′ N., long. 123° 32′ E.; 18 fathoms; mud.

Pectinura arenosa, Lym. (Pl. XXIII. figs. 10–12).

Pectinura arenosa, Lym., Bull. Mus. Comp. Zool., vol. vi., part 2, p. 48, pl. xiv. figs. 392–394, 1879.

Nine to eleven short arm spines. Disk uniformly granulated, with about 8 grains in 1 mm. long. No water pores between under arm plates.

(Type specimen from Station 162.) Diameter of disk 10 mm.; length of arm about 42 mm. Width of arm close to disk 2 mm. Fifteen short, stout, pointed, crowded mouth papillæ, the three outermost being somewhat the widest. Mouth shields rounded triangular, about as broad as long, with a blunt angle inward and outer side straight. Supplementary shield semicircular, and about two-thirds as large as the true shield. Side mouth shields very small, and short, occupying part of the outer angles of mouth shield, and widely separated within. First under arm plate wide and large, and nearly semicircular, though the inner side is not quite straight; those beyond are as broad as long. There are no water pores between the plates. Side arm plates flat and not swollen, separated above and below. Upper arm plates short rounded oval; somewhat broader than long. Disk somewhat angular and slightly swollen, closely covered above and below, except the mouth shields and side mouth shields, with a fine granulation, about 8 grains in the length of 1 mm.

Genital openings extending from mouth shield about two-thirds the distance to the margin. Nine to eleven short, stout, somewhat flattened peg-like arm spines, all about half as long as the side arm plate, except the lowest, which equals it. Two small rounded tentacle scales on the side arm plate, whereof that on the interbrachial side overlaps the base of the lowest arm spines. Colour in alcohol, disk pale yellowish-brown, above; arms darker, with irregular belts of black and yellowish-brown.

Station 162.—April 2, 1874; off East Moncur Island, Bass Strait; 38 fathoms; sand.

This species stands between *Pectinura spinosa* and *Pectinura infernalis*.

Pectinura heros, Lym. (Pl. XXIII. figs. 7–9).

Pectinura heros, Lym., Bull. Mus. Comp. Zool., vol. vi., part 2, p. 48, pl. xiv. figs. 389–391, 1879.

Three very short arm spines, low down on the side arm plate. No pores between lower arm plates. One round tentacle scale.

(Type specimen from Station 191.) Diameter of disk 22 mm. Length of arm about 100 mm. Width of arm close to disk without spines 4 mm. Fifteen small, close-set mouth papillæ to each angle, whereof the two or three outer ones on each side are flat, rounded, and larger than the rest, which are pointed; there are two just under the teeth, and sometimes two supplementary below and outside these. Mouth shields long, heart-shaped, with a rounded angle within; length to breadth 3 : 2·2. Sometimes a rudimentary supplementary piece may be seen, just outside. Side mouth shields three-cornered and small, occupying only the outer corners of the mouth shield. Under arm plates about as wide as long, bounded without by a curve, within by a truncated angle, and laterally by re-entering curves. Side arm plates short, with rounded edges, meeting neither above nor below. Upper arm plates broad, highly arched, closely overlapping, with outer and inner edges nearly straight. Disk flat and angular, closely and evenly covered with very fine granules, 7 or 8 in the length of 1 mm., except the radial shields and one or more plates along the margin. Radial shields egg-shaped, longer than broad, with outer and inner ends much rounded; length to breadth 3·7 : 2. Lower interbrachial space covered by same granulation as above, extending even to the mouth angle, but not on mouth shields. Genital opening long, extending from mouth shield to margin of disk. Three short, small, blunt arm spines standing low on the side arm plate, and about half as long as a joint. One round tentacle scale. Colour in alcohol white.

Station 191.—September 23, 1874; lat. 5° 41′ S., long. 134° 4′ E.; 800 fathoms; mud.

This species stands as near to *Pectinura stellata* as to any; there are, however, no pores between the under arm plates, and but three short arm spines. The only occasional presence of rudimentary supplementary mouth shields points once more to the very close connection between *Ophiopeza* and *Pectinura*.

Species of *Pectinura* not herein described.

Pectinura vestita, Fbs., Linn. Trans., vol. xix. p. 143, pl. xiii. figs. 1–7, 1842; Ltk., Addit. ad Hist., vol. iii. p. 31; Lym., Bull. Mus. Comp. Zool., vol. iii., part 10, p. 222; Ludwig, Echin. des Mittelmeeres, p. 546.

Ophiarachna vestita, Lym., Ill. Cat. Mus. Comp. Zool., vol. i. p. 11.

Ægean Sea; South Adriatic; 100 fathoms.

Pectinura infernalis, Ltk., Addit. ad Hist., part 3, p. 33, 1869; Lym., Bull. Mus. Comp. Zool., vol. iii. part 10, p. 222, pl. vii. fig. 1.

Ophiarachna infernalis, Müll. & Tr., Syst. Ast., p. 105, 1842.

Great Ocean.

Pectinura marmorata, Lym., Bull. Mus. Comp. Zool., vol. iii., part 10, p. 222, pl. v. figs. 1–7, 1874.

Philippines.

Pectinura septemspinosa, Ltk., Addit. ad Hist., part 3, p. 33, 1869; Lym., Bull. Mus. Comp. Zool., vol. iii., part 10, p. 222, pl. vi. figs. 10–13.

Ophiura septemspinosa, Kuhl. & v. Has., MS.
Ophiarachna septemspinosa, Müll. & Tr., Syst. Ast., p. 105, 1842.

Great Ocean.

Pectinura spinosa, Lym., Bull. Mus. Comp. Zool., vol. iii., part 10, p. 221, 1874.

Ophiarachna spinosa, Ljn., Oph. Viv. Öf Kong. Akad., p. 305, 1866.
Ophiopezella spinosa, Ljn., Dr. Goës, Oph. Öf. Kong. Akad., p. 639, 1871.

Foua Islands.

Pectinura verrucosa, Studer, Monatsb. König. Akad. Berlin, p. 461, July 1876.

Kerguelen Island; 150 fathoms.

Ophiopæpale.

Ophiopœpale, Ljn., Dr Goës, Oph. Öf. Kong. Akad., 1871.

Disk granulated. Teeth, and numerous even, close-set, mouth papillæ. No tooth papillæ. Three slender, short, smooth arm spines. One small tentacle scale. Arms long, cylindrical, and gradually tapering to a fine point, their under plates divided into two parts, an inner tongue, and an outer piece which is of a transverse oblong shape, Two genital openings in each interbrachial space.

The skeleton presents stout genital plates, with clubbed ends, much as in *Ophiura*, and having attached a long, thin genital scale broken in two or more pieces. The peristomial plates are in two stout pieces, which form together a wide heart-shape. Arm bones as high as wide, with long tops, having a deep longitudinal canal, while their wings are thin and have sharp edges. In contrast to the delicate imbricated scaling of the disk is the size of the radial shields, which touch each other, are very wide, and have a process inward. (See Pl. XXXVII. figs. 4–6.)

Species of *Ophiopæpale* not herein described.

Ophiopæpale goësiana, Ljn. (Pl. XXXII. figs. 4–6).

Ophiopæpale goësiana, Ljn., Dr Goës, Oph. Öf. Kong. Akad., 1871, p. 615; Lym., Bull. Mus. Comp. Zool., vol. v. part 9, p. 228.

West Indies; 100 to 180 fathoms.

Ophiogona.

Ophiogona, Studer, Monatsb. König. Akad. Berlin, July 1876.

Mouth papillæ, about fourteen to each angle. Teeth in a double row; no tooth papillæ. Disk clothed with fine scales, covered by a soft skin; and without notches in its upper sides, at the basis of the arms. Numerous (3–6) flat tentacle scales, arranged along transverse pores. Nine short arm spines. Mouth shields long and extending into the interbrachial space, which has two genital openings.

Species of *Ophiogona* not herein described.

Ophiogona lævigata, Studer, Monatsb. König. Akad. Berlin, p. 460, July, 1876.

Kerguelen Islands; 120 fathoms.

Ophiolepis.

Ophiolepis, Müll. & Tr., Wieg. Arch., vol. vi., 1840.

Disk covered with radial shields and stout plates; each larger one, above, being surrounded by a belt of smaller ones. Over the base of each arm, a small notch in the disk. Genital scales thick and conspicuous. Teeth; no tooth papillæ; numerous even, close-set mouth papillæ. Side mouth shields wide, and nearly, or quite, meeting within. Arm spines short and small, supplementary pieces to the upper arm plates. Two short genital openings, beginning at the sides of the mouth shields.

As compared with the massive disk plates, the skeleton proper is somewhat slight,

except the strong genital plates, which have a long, thick head, to which is attached the genital scale, at a point far inward, so that the genital opening is much shortened (*Ophiolepis cincta*), or, what amounts to the same, the scale may, for a part of its length, be soldered to the plate (*Ophiolepis elegans*). The peristomial plate may either be thin and in one piece (*Ophiolepis elegans*), or thick and divided in two (*Ophiolepis cincta*). On the edge of the wings of the arm bones are grooves. The first mouth tentacle is enclosed in a tube of lime scales, a feature observed also in *Ophioglypha*, *Pectinura*, *Ophiura*, &c. (See Pl. XXXVII. figs. 7–9.)

TABLE OF SPECIES OF *Ophiolepis*.

1 scale-like arm spine. Mouth papillæ in two rows, one above the other,	*Ophiolepis carinata*.
2 very short arm spines, ...	*Ophiolepis paucispina*.
4 minute arm spines. The beltings of smaller disk scales, uniform above and below, ...	*Ophiolepis cincta*.
4–5 arm spines. Disk plates forming a nearly smooth surface, .	*Ophiolepis variegata*.
5–6 arm spines, otherwise similar to preceding, . . .	*Ophiolepis elegans*.
6–7 arm spines. Disk plates forming a rough broken surface, .	*Ophiolepis annulosa*.

Ophiolepis cincta, Müll. & Tr. (Pl. XXXVII. figs. 7–9).

Ophiolepis cincta, Müll & Tr., Syst. Ast., p. 90, 1842; Ltk., Addit. ad Hist., part 2, p. 101, pl. ii. fig. 6; Lym., Ill. Cat. Mus. Comp. Zool., No. i. p. 60.
Ophiolepis Garretti, Lym., Ill. Cat. Mus. Comp. Zool., No. i. p. 61, pl. ii. fig. 4, 1865.

Station 186, Samboangan, Philippine Islands; 8 fathoms.

Ophiolepis annulosa, Müll. & Tr., Wieg. Arch., vol. vi. p. 328, 1840; Syst. Ast., p. 89, 1842; Ltk., Addit. ad Hist., part 2, p. 100, pl. ii. fig. 5; Lym., Ill. Cat. Mus. Comp. Zool., No. i. p. 58.

Ophiura annulosa, Blainv. (*non* Lmk.), Actinol., p. 244, tab. xxiv., 1834.

Station 186.—September 8, 1874; Ternate Shore near Celebes; 8 fathoms; coral sand.

Species of *Ophiolepis* not herein described.

Ophiolepis paucispina, Müll. & Tr., Syst. Ast., p. 90, 1842; Lym., Ill. Cat. Mus. Comp. Zool., No. i. p. 55; Ltk., Addit. ad Hist., part 2, p. 102, pl. ii. fig. 2.

Ophiura paucispina, Say, Journ. Phil. Acad., vol. v. p. 149, pl. i., 1825.

West Indies; 3 to 4 fathoms.

Ophiolepis elegans, Ltk., Addit. ad Hist., part 2, p. 105, 1859; Lym., Ill. Cat. Mus. Comp. Zool., No. i. p. 58, pl. ii. fig. 5.

West Indies; 8½ to 30 fathoms.

Ophiolepis variegata, Ltk., Vid. Meddel., March 1856, p. 23; Addit. ad Hist., part 2, p. 106, pl. ii. fig. 7; Lym., Ill. Cat. Mus. Comp. Zool., No. i. p. 10; Vll., Trans. Conn. Acad., vol. i., part 2, p. 256.

West Coast of Central America.

Ophiolepis carinata, Studer, Monatsb. König. Akad. Berlin, July 1876, p. 460.

Kerguelen Island; 60 to 65 fathoms.

Ophioplocus.

Ophioplocus, Lym., Proc. Bost. Soc. N. H., vol. viii., 1861.

Disk closely and finely scaled above and below. Genital scales hidden. Teeth. No tooth papillæ. Numerous even, close-set mouth papillæ. Side mouth shields wide, and nearly or quite meeting within. Three short, stout arm spines. Upper arm plates divided on the middle line into halves, which, at the base of the arm are placed at the outer lower corner of the joint on each side, and are separated by a number of supplementary pieces. At the tip of the arm the plate is simple; then it divides in two, and the halves are gradually forced apart by the intrusion of supplementary pieces. Two short genital openings in each interbrachial space, extending only half-way to the margin of the disk, and beginning outside the mouth shields.

In disk-scaling and radial shields it bears some resemblance to *Ophiura*. The genital plate also is similar, except that its scale is attached very far inward, thus shortening the genital opening. There is almost no groove along the edges of the arm bone wings. The halves of the stout peristomial plate make a wide heart-shape. (See Pl. XXXVII. figs. 10–12.)

Species of *Ophioplocus* not herein described.

Ophioplocus imbricatus, Lym. (Pl. XXXVII. figs. 10–12).

Ophiolepis imbricata, Müll & Tr., Syst. Ast., p. 93, 1842; Ltk., Addit. ad Hist., part 2, p. 160.
Ophioplocus tessellatus, Lym., Proc. Bost. Soc. Nat. Hist., vol. viii., p. 76, 1861.
Ophioplocus imbricatus, Lym., Ill. Cat. Mus. Comp. Zool., p. 69, 1865.

Great Ocean.

Ophioplocus esmarki, Lym., Bull. Mus. Comp. Zool., vol. iii., part 10, p. 227, pl. v. figs. 12–14, pl. vi. fig. 6, 1874.

San Diego, and near Santa Barbara, Cal.; 22 fathoms.

Ophiozona.

Ophiozona, Lym., Ill. Cat. Mus. Comp. Zool., No. i., 1865.

Disk covered with radial shields and stout scales. The larger mingled with lines of smaller ones. Over the base of each arm, a small notch in the disk. Genital scales thick and conspicuous. Teeth. No tooth papillæ. Numerous even, close-set mouth papillæ. Side mouth shields wide, and nearly or quite meeting within. Few (2–5) short arm spines usually arranged not along the outer edge of the side arm plates but on their outer corner, so that the spines stand at an angle with the arm. No supplementary pieces to the upper arm plates. Two genital openings, beginning at the sides of the mouth shields.

The skeleton presents a stout, flat, somewhat curved genital plate with a clubbed end, and a genital scale of equal length which runs below it, and is for some distance, soldered to it. The peristomial plate is thick and swollen; sometimes single, and sometimes divided in two. Of the discoid arm bones, those within the disk are scarcely grooved on their edges, while those beyond have grooves and thinner wings. Seen from within the upper disk is set with stout, strongly overlapping plates, and oblong separated radial shields. (See Pl. XXXVII. figs. 13–15.)

Table of Species of *Ophiozona.*

Two tentacle scales.	4–5 arm spines. Small separated radial shields,	Arm spines nearly as long as side arm plates; lowest one longest,	*Ophiozona impressa.*
		Arm spines equal and very short,	*Ophiozona pacifica.*
	4 arm spines,	Radial shields large and touching,	*Ophiozona nivea.*
		Radial shields large and separated. Two scales on first two tentacle pores only,	*Ophiozona insularia.*
	3 arm spines,	Large radial shields, bearing a blunt spine on their outer end,	*Ophiozona tessellata.*
One tentacle scale.	2–3 arm spines,	Radial shields small and separated,	*Ophiozona stellata.*
		Large pointed radial shields nearly touching at their middle point,	*Ophiozona antillarum.*
		Large, oval, well separated radial shields,	*Ophiozona depressa.*
		Radial shields wide and touching. First side arm plates very wide, and extending into centre of interbrachial space,	*Ophiozona* (?) *dubia.*

Ophiozona impressa, Lym. (Pl. XXXVII. figs. 13–15).

Ophiolepis impressa, Ltk., Addit. ad Hist., part 2, p. 101, pl. ii. fig. 3, 1859.
Ophiozona impressa, Lym., Ill. Cat. Mus. Comp. Zool., No. i. p. 64, fig. 4, 1865.

Bahia; 7 to 20 fathoms.

Ophiozona nivea, Lym., Ill. Cat. Mus. Comp. Zool., No. viii., part 2, p. 9, 1875, outline figs. 85, 86; Bull. Mus. Comp. Zool., vol. v., part 7, p. 128; vol. v., part 9, p. 221.

Station 24.—March 25, 1873; off Culebra Island; 390 fathoms; mud.

Ophiozona insularia, Lym. (Pl. XI. figs. 10–12).

Ophiozona insularia, Lym., Bull. Mus. Comp. Zool., vol. v., part 7, p. 126, pl. vi., figs. 149–151, 1878.

Four short, nearly equal arm spines. Arm high. Side arm plates swollen, and strongly flaring outward. Radial shields large, rounded triangular, widely separated.

(Type specimen from Station 173.) Diameter of disk 6 mm. Length of arm about 18 mm. Width of arm close to disk, without spines, 1·6 mm. Five short, squarish, close-set mouth papillæ on each side, one large spearhead shaped at apex of angle. Mouth shield longer than broad, with a very deep curve without, and an angle within; length to breadth, 1 : ·8. Side mouth shields short and thick, rather wider without than within where they meet. First under arm plate very small, tranverse oval in shape; second, third, and fourth plates large and five-sided, with inner angle truncated, small re-entering curves on the lateral sides, and outer edge slightly curved; beyond, they approach a fan-shape, with an angle inward. Side arm plates broad, swollen, and flaring outward, just meeting below beyond the fifth under arm plate, and above beyond the fifth or sixth arm plate, which is fan-shaped, with an angle inward. Disk rounded pentagonal and flat, with a large central plate, and five others round it, separated from each other by a wedge-scale; interbrachial spaces filled by four angle plates, a large one within, outside this two smaller, and then a squarish marginal plate. Radial shields swollen, longer than wide, three-sided, with angles rounded, separated throughout their entire length by a wedge of three plates whereof the innermost is largest and connects with a primary plate; length to breadth 1·3 : 1. Lower interbrachial space covered by two very irregular transverse rows of long rounded plates. Genital scales long and narrow, curved and tapering. Four short blunt arm spines, the three lowest longest, and about half as long as an arm joint. Two tentacle scales on the first two pairs of tentacle pores, a small one within and larger one without; beyond this there is only one large round scale. Colour in alcohol, white.

A smaller specimen, whose diameter of disk was 3·5 mm., was similar, except that the disk plates fewer and more regular, and the radial shields were scarcely separated.

Station 173.—July 24, 1874; off Matuka, Fiji Islands; 310 fathoms; coral.

Ophiozona stellata, Lym. (Pl. XI. figs. 13–15).

Ophiozona stellata, Lym., Bull. Mus. Comp. Zool., vol. v. part 7, p. 125, pl. vi. figs. 147, 148, 1878.

Two short arm spines placed low on the plate, the lower one twice as long as the

upper. Arm somewhat flattened, side arm plates not swollen. Radial shields small, irregular, widely separated.

(Type specimen from Station 168.) Diameter of disk 9 mm. Length of arm about 35 mm. Width of arm close to disk, without spines, 1·8 mm. Four squarish close-set mouth papillæ on each side, and two longer and more pointed at angle of jaw. Four short stout teeth, the lowest thickened and rounded. Mouth shields three sided, with a long angle within, and outer edge much curved; length to breadth 1·8 : 1·8. Side mouth shields short and thick, wide without; tapering to a point within, where they just meet. First under arm plate very small, transverse oval in form; second plate wider without than within, four-sided, having lateral sides re-enteringly curved and a peak without; those beyond are similar, but nearly pentagonal. Side arm plates broad and thick, meeting below beyond the fourth under arm plate, and above beyond the second upper arm plate, which is fan-shaped, with an angle inward. Disk flat and rather thin, covered with stout, rounded, microscopically tuberculous plates, whereof a large primary occupies the centre, with five others about it, separated in the interbrachial space by a radiating row of two or more scales; outside these, again, is a row of ten semicircular plates with small scales between; near each interbrachial margin are two plates side by side; on the lower interbrachial space are three transverse rows of irregularly shaped plates. Genital scales composed of three irregular pieces placed end to end. Genital openings extending from outer edge of mouth shield to margin. Two short, stout, blunt, tapering arm spines placed low on the side arm plate, the lower one twice as long as the upper, and about half as long as an arm joint. One large rounded tentacle scale on the inner side of the tentacle pore. Colour in alcohol pale grey.

A young specimen with a disk of 2·8 mm. had arms 5 mm. long. The disk was more arched, and its plates, of course fewer, were microscopically tuberculous. The side mouth shields were very large and swollen, and the mouth shields small. The first under arm plate larger than in the adult, and the rest much smaller proportionately.

Station 168.—July 8, 1874; lat. 40° 28′ S., long. 177° 43′ E.; 1100 fathoms; grey ooze.
Station 169.—July 10, 1874; lat. 37° 34′ S., long. 179° 22′ E.; 700 fathoms; grey ooze.

Ophiozona antillarum, Lym. (Pl. XI. figs. 7–9).

> *Ophiozona antillarum*, Lym., Bull. Mus. Comp. Zool., vol. v., part 7, p. 127, pl. vi. figs. 152–154, 1878.

Two short arm spines, upper one longer. Arm of medium height. Side arm plates somewhat flaring outward. Radial shields large, pointed without and within, nearly joined at their middle point.

(Type specimen from Station 23.) Diameter of disk 8 mm. Width of arm, without spines, close to disk 1·8 mm. Four short, rounded, close-set mouth papillæ on each side, and two longer and sharper at apex of angle. Mouth shields as long as broad, with an

angle within, bounded by re-entering curves, and outer edge much rounded; length to breadth 1.5 : 1.3. Side mouth shields short and thick, wide without, meeting broadly within. First under arm plate small, pointed, transverse oval in shape; second plate large pentagonal, with inner angle truncated, lateral sides having a short but deep re-entering curve, and outer edge neatly curved; the plates beyond have a long sharp angle within, and very short lateral sides. Side arm plates wide, and somewhat swollen, and flaring outward, meeting below beyond the fourth under arm plate, and above beyond the first upper plate, which is much swollen and narrow fan-shaped, with an angle inward. Disk round flat, and rather thin; in centre a rosette of six large, irregular, rounded primary plates, the five outer ones separated from each other by pairs of small, thick, angular scales. In the interbrachial spaces are numerous small, and three large plates in a radiating line, two long hexagonal and one larger and rounded on the margin. Radial shields somewhat sunken, longer than wide, with irregularly curved outlines, and a blunt angle within and without, separated at their inner end by a large hexagonal plate, and without by a small triangular plate. Lower interbrachial space filled by three transverse rows of irregular plates. Genital scales long and narrow, and composed of several pieces. Two short, stout, blunt pointed arm spines, the upper one longer, and two-thirds as long as an arm joint. One large round tentacle scale on each pore. Colour in alcohol, white.

Station 23.—March 15, 1873; off Sombrero Island; 450 fathoms; globigerina ooze.

Ophiozona depressa, Lym. (Pl. XI. figs. 16–18).

Ophiozona depressa, Lym., Bull. Mus. Comp. Zool. vol. v., part 7, p. 128, pl. vi. figs. 155–157, 1878.

Two nearly equal short arm spines. Arm low. Side arm plates slightly flaring without. Radial shields large, oval, and widely separated.

Diameter of disk 11 mm. Length of arm about 37 mm. Width of arm close to disk, without spines, 1·8 mm. Four short, squarish, close-set mouth papillæ on each side, the outer one very small, and a pair somewhat more pointed at apex of angle. Mouth shields longer than broad, with a sharp angle within, and outer side bounded by a deep curve; length to breadth 2 : 1·7. Side mouth shields short, broad without tapering inward, where they meet in a point. First under arm plate very small, transverse pointed oval; next two plates long pentagonal, with a truncated angle within, deep re-entering curve on each inner lateral corner, and a curved outer edge; beyond these the plates are short pentagonal. Side arm plates low (the arm being flat), little swollen, slightly flaring outward, meeting below beyond the fifth under arm plate, and above beyond the second upper plate, which is fan-shaped, with an angle within. Disk round and flat; in the centre is a large pentagonal primary plate, round which are five others, smaller and more or less rounded, separated from each other by a triangular scale. These primary plates have a little central boss or tubercle; in the

interbrachial spaces is a radiating row of three large elongated plates, the outer and longest being marginal. Radial shields flat, longer than broad, oval, separated their entire length by two large plates; length to breadth 2·5 : 1·7 mm. Lower interbrachial space filled by irregular transverse rows of uneven plates, the outer row long and angular. Genital scales long, narrow, and broken in several pieces. Genital opening not extending to margin of disk. Two short, blunt, tapering arm spines of equal length, and about half as long as an arm joint. One large rounded tentacle scale on the inner side of each tentacle pore. Colour in alcohol, white.

Station 214.—February 10, 1875; near Philippines; lat. 4° 33′ N., long. 127° 6′ E.; 500 fathoms; globigerina ooze.

Ophiozona (?) *dubia*, Lym., Bull. Mus. Comp. Zool., vol., v. part 9, p. 224, pl. ii. figs. 19–21, 1878.

Station 23.—March 15, 1873; close to Sombrero Islands; 450 fathoms; globigerina ooze.

Species of *Ophiozona* not herein described.

Ophiozona pacifica, Lym., Ill. Cat. Mus. Comp. Zool., No. i. p. 67, 1865.

Ophiolepis pacifica, Ltk., Vid. Meddel., March, 1856, p. 22; Addit. ad Hist., part 2, p. 104, pl. ii. fig. 4; Vll., Trans. Conn. Acad., vol. i. part 2, p. 257.

Puntarenas; Panama; 1 fathom.

Ophiozona tessellata, Lym., Bull. Mus. Comp. Zool., vol. v., part 9, p. 223, pl. iii. figs. 43–45, 1878.

West Indies; 242 fathoms.

Ophioceramis.

Ophioceramis, Lym., Ill. Cat. Mus. Comp. Zool., No. i., 1865.

Disk covered with radial shields and stout plates, none of which are surrounded by a belt of small ones. Over the base of each arm, a small notch in the disk. Genital scales concealed. Teeth. Tooth papillæ. Mouth papillæ. Side mouth shields small, and not meeting within. No supplementary pieces to the upper arm plates. Two genital openings, beginning outside the mouth shields.

While the genital plate is not unlike that of *Ophiozona*, the genital scale is shorter, being attached at some distance inward from the head of the plate; and, instead of a thick peristomial plate there is only a rudimentary crust covering the nerve ring. In respect to the mouth angles, there is no similarity with the group of *Ophiolepis*, &c. Not only are the mouth frames much larger with wide crested wings, but the first arm bone has an unusual form and is very long and large. (See Pl. XXXVII. figs. 16–18.)

Ophioceramis (?) *clausa*, Lym. (Pl. XI. figs. 4–6).

Ophioceramis (?) *clausa*, Lym., Bull. Mus. Comp. Zool., vol. v., part 7, p. 124, pl. vi. figs. 161–163, 1878.

Four arm spines, the two upper slender and tapering, the two lower stout and blunt. A great marginal scale, which occupies also most of the lower interbrachial space.

(Type specimen from Station 170.) Diameter of disk 4 mm. Length of arm about 18 mm. Width of arm without spines 1·2 mm. Three short, stout, pointed mouth papillæ, well separated on each side, with one larger and spearhead shaped at the apex of angle. Mouth shields broader than long, transverse diamond-shape, with outer angle indented; length to breadth ·6 : 1. Side mouth shields very large and wide, somewhat longer than wide, square without, meeting broadly within, and there forming a deep angle. First under arm plate broader than long, rounded; the rest are widely separated, twice as broad as long, with outer edge nearly straight, a very obtuse angle or weak curve within, and a small re-entering curve on the lateral sides. Side arm plates stout, flaring a little outward where they form the spine ridge, meeting broadly above and below. Upper arm plates broader than long, wide fan-shape with an angle inward, somewhat swollen, making the arm high and rounded. Disk round and flat, covered with thin, flat, angular scales arranged symmetrically; central primary plate pentagonal, surrounded by five others rounded hexagonal and somewhat smaller; interbrachial spaces filled by three large scales, the two inner ones four-sided, the outer one rounded and lying on the margin, showing little above, but beneath occupying the whole interbrachial space except two small scales outside the mouth shields. Radial shields regular, longer than broad, wide without, coming by curved sides to a point within, where they are separated by a small triangular scale, but are joined for the rest of their length; they, as well as the other disk scales, bear a few microscopic tubercles. Four arm spines; the two upper thin and tapering, and nearly as long as an arm joint; the two lower shorter, stouter, and more blunt; towards tip of arm there are three, the upper long and slender, as long as two joints; the second similar, but shorter; and the lowest very stout and somewhat curved. One very small rounded tentacle scale, on the first two pairs of tentacle-pores; beyond there are two. Colour in alcohol, pale brown.

Station 170.—July 14, 1874; lat. 29° 45′ S., long. 178° 11′ W.; 630 fathoms; rock.
Station 171.—July 15, 1874; lat. 28° 33′ S., long. 177° 50′ W.; 600 fathoms; rock.

Ophioceramis (?) *obstricta*, Lym. (Pl. XI. figs. 1–3).

Ophioceramis (?) *obstricta*, Lym., Bull. Mus. Comp. Zool., vol. v., part 7, p. 124, pl. vi. figs. 164–166, 1878.

Five short, nearly equal, blunt, tapering arm spines. Radial shields separated in the brachial spaces, but touching in the interbrachial.

(Type specimen from Station 192.) Diameter of disk 4 mm. Length of arm about 12 mm. Width of arm close to disk, without spines, 1·2 mm. Seven small, short, rounded mouth papillæ to each mouth angle, the inner one longer and more prominent. Three squarish teeth, the upper one very small. Mouth shields broader than long, inner angle broad and rounded, lateral corners rounded, and outer edge much curved; length to breadth ·7:·6. Side mouth shields large, somewhat swollen, square, and wide without; tapering slightly inward, where they just meet. First under arm plate rounded and conspicuous; the plates beyond are short pentagonal, with an angle inward. Side arm plates thick and somewhat flaring outward, meeting broadly below and also above beyond the first, which is broader than long, four-sided, with slight re-entering curves on the lateral sides, and outer corners rounded; beyond, the plates are pentagonal, with an obtuse angle inward, and lateral and outer sides straight. Disk thin and sunken, and contracted in the interbrachial spaces, covered with small overlapping plates; in centre are six rudely angular primaries separated in the interbrachial spaces by several minute rounded scales. Radial shields large, longer than broad, swollen, raised above the surrounding scales, having a long angle inward and outer angles rounded; separated their whole length by an inner and outer wedge, each composed of two small quadrangular plates; length to breadth 1·5:·8: each shield touches that of the neighbouring pair by its interbrachial edge, and is separated without by a marginal wedge-like scale. Lower interbrachial space with a row of scales on the margin, the central one being larger with edges rounded, its inner edge touching the mouth-shield. Genital scales short and thick, composed of two or three angular pieces. Five short, blunt, tapering arm spines, about two-thirds as long as an arm joint, extending along the entire edge of the side arm plate. One pointed tentacle scale, so minute as to be seen with difficulty. Colour in alcohol, pale brown.

Station 192.—September 26, 1874; lat. 5° 42′ S., long. 132° 25′ E., 129 fathoms; mud.

Species of *Ophioceramis* not herein described.

Ophioceramis januarii, Lym. (Pl. XXXVII. figs. 16–18).

Ophiolepis Januarii, Ltk., Vid. Meddel., Jan. 1856, p. 10; Addit. ad Hist., part 2, p. 108, pl. ii. fig. 1, 1859.

Ophioceramis januarii, Lym., Ill. Cat. Mus. Comp. Zool., No. i. p. 62, 1865.

Barbadoes; East Patagonia; Brazil; 35 to 100 fathoms.

Ophioceramis albida, Lym., Ill. Cat. Mus. Comp. Zool., No. viii., part 2, p. 10, pl. iii. figs. 29–31, 1875.

Amphipholis albida, Ljn., Oph. Viv. Öf. Kong. Akad., p. 314, 1866.

Barbadoes; Brazil; off Rio La Plata; 19 to 100 fathoms.

Ophiothyreus.

Ophiothyreus, Ljn., Öf. Kong. Akad., 1871.

Disk and arms enclosed by stout, swollen plates. Large tentacle pores quite to the end of the arm, closed by thick scales. Arm spines few and minute. A row of papillæ passes along the outer edges of the genital scales and of the radial shields; between the latter is wedged a pair of plates (a divided upper arm plate), along whose inner edges runs a corresponding row of fine papillæ. Two genital openings in each interbrachial space. Although small as seen from above, the radial shields from the inside are found to be so large, as to form a closed ring round the disk margin.

The genital plate is short and stout with an extremely wide clubbed head, to which is joined the short, flat, very thick genital scale. Peristomial plate large, and composed of two closely soldered halves. The arm bones are pretty stout, the first two being discoid, and not grooved on the edges, while those beyond are much longer on top.

Species of *Ophiothyreus* not herein described.

Ophiothyreus goësi, Ljn., Dr Goës, Oph. Of. Kong. Akad., p. 619, 1871; Lym., Bull. Mus. Comp. Zool., vol. v., part 9, p. 222.

West Indies; 80 to 300 fathoms.

Ophioplinthus.

Ophioplinthus, Lym., Bull. Mus. Comp. Zool., vol. v., part 7, 1878.

Disk smooth and covered by a thin skin bearing irregular delicate scales and radial shields. Genital scales wide and divided in several pieces. Small, blunt, close-set mouth papillæ; no tooth papillæ; short angular teeth; very minute, peg-like arm spines on outer edges of side arm plates. Second pair of mouth tentacles and first two pairs of arm tentacles rising from round pores near the inner end of the under arm plates; those beyond are smaller, and stand close to the under arm spine. Arms narrow, cylindrical, and gradually tapering. Two genital openings, running only a part of the way toward the margin. Mouth frames seen from above, after removing the top of the disk, long and rising in a ridge, so that in the interbrachial space is a wide angle, and in the brachial space a deep trough. Arm bones long and cylindrical, with only a faint upper furrow. Genital scales long, slender, and cylindrical.

This genus by its large first under arm plate has a slight relation to *Ophioglypha*, and by its large tentacle pores at base of arm, an appearance like *Ophiomusium*, but its structure is really quite peculiar.

It has slender connection with any of its neighbours (unless perhaps with *Ophiopleura*). The disk covering, though thin and translucent is really composed of rounded

plates. The mouth frames are low and depressed with great sockets for the first mouth tentacles. There is nothing but a thin lime crust to represent the peristomial piece. The slender, cylindrical genital plate is so long as to reach the mouth shields, and is broken in several pieces; for a quarter of its outer length there is united to it the genital scale, which then spreads out like a thin wing. The arm bones within the disk are long and cylindrical, instead of short and discoidal. Just outside the disk they are still more elongated with a median contraction; and they present a complex arrangement of processes and hollows. (See Pl. XXXVIII. figs. 1–5.)

Ophioplinthus medusa, Lym. (Pl. XXIV. figs. 7–9; Pl. XXXVIII. figs. 1–5).

Ophioplinthus medusa, Lym., Bull. Mus. Comp. Zool., vol. v., part 7, p. 105, pl. ii. figs. 30, 31, 40, 1878.

Scaling of lower interbrachial space coarse (four or five scales in a transverse row). No scales on arm tentacles. Usually three very minute, peg-like arm spines, equally spaced.

(Type specimen from Station 156.) Diameter of disk 16 mm. Width of arm 2 mm. Mouth papillæ short, square, closely soldered, four or five on each side, with one, diamond shaped, at apex of the jaw. Mouth shields rounded triangular, with an angle inward, sides curved, and often a re-entering curve without; they are frequently furrowed or cracked. Side mouth shields irregularly rhomboidal, sometimes broader within, where they touch. First under arm plate rounded triangular, with a blunt angle inward, and a long curved outer edge; second plate five-sided, with an obtuse angle within, and a curved outer edge; beyond this they are broader than long, with a blunt angle within and a wavy curve without. Side arm plates thick and smooth, meeting broadly below and touching above beyond the sixth plate. Upper arm plates rounded diamond shaped, with a longer angle within; they often are cracked or grooved. Disk high, covered with thin, irregular, overlapping plates; the central primary one about 2 mm. in diameter and conspicuously the largest, and in each brachial space is a primary plate larger than the rest. Radial shields irregular, four sided, with rounded corners, broader on the outer edge, separated their entire length by a broad wedge of small scales. On the under surface of the disk are numerous irregular plates between the genital scales, which are thick, with a wavy outline. The genital opening runs less than half-way to the margin. Three very short, blunt arm spines, situated low on the outer edge of the side arm plate. A pair of small tentacle pores, each surrounded by a raised burr, situated near the inner angle of the second under arm plate, on its edge; and a similar but minute pair on the third plate. Beyond this the pores are difficult to see and lie near the base of the under arm spine. The second pair of mouth tentacles protrude from an oval rim, having on each side a couple of ill-defined tentacle scales. Colour in alcohol, grey.

The disk is covered by a thick skin which much obscures the plates. In the young there are two pairs of feeble tentacles, outside the mouth; but none in the adult.

The disk and arms had clinging to them small polyp-like creatures, about 2 mm. high, and which seemed unquestionably the Scyphistoma stage of some Medusa, like *Cyanea*. It is not easy to guess what they were doing 12,000 feet below the surface of the ocean.

Station 156.—February 26, 1874; lat. 62° 26′ S., long. 95° 44′ E.; 1975 fathoms; diatom ooze.

Ophioplinthus grisea, Lym. (Pl. XXIV. figs. 10–12).

Ophioplinthus grisea, Lym., Bull. Mus. Comp. Zool., vol. v., part 7, p. 106, pl. ii. figs. 33, 34.

Scaling of lower interbrachial space fine (ten or twelve in a transverse row). Very small, bead-like scales on first two pairs of arm tentacles. Two or three very minute, peg-like arm spines, situated low down. Arms short and narrow.

(Type specimen from Station 156.) Diameter of disk 20 mm. Width of arm close to disk, without spines, 2 mm. Mouth papillæ short, thick, closely soldered together, about six on each side, with two longer blunt papillæ at apex of jaw. Mouth shields small, very broad heart-shape, with a peak within, often cracked in two or more pieces. Side mouth shields small, narrow, not meeting within, and so covered by the skin as to be seen with difficulty. First under arm plate large, three-sided, with inner angle much rounded and outer edge slightly curved; second and third pentagonal, with sharp angle inward, lateral sides re-enteringly curved, outer edge slightly rounded; those beyond are rounded diamond-shape, and much broader than long. Side arm plates smooth, meeting broadly below, slightly swollen along their outer edge. The basal upper arm plates are as wide as long, of a general oval form, wider without than within, and having a deep median groove. Disk covered with thin, rounded, irregular plates and scales, having six large rounded primary plates, one in the centre and one to each brachial space. Radial shields very irregular, rudely triangular or quadrangular, with rounded corners, separated their entire length by three or more rows of disk scales; length to breadth 3 : 3. On the under surface of the disk the scales are small and very thin; the genital scales are long and narrow, with an irregular wavy outline and often broken in three pieces. The genital opening extends less than half-way to the margin. The minute blunt arm spines, of which the under one is largest, stand low, on the side arm plate. The second pair of mouth tentacles issue from large pores, surrounded by a rim of minute, ill-defined papillæ; the tentacles of the second and third under arm plates issue in like manner from smaller pores; beyond this the small tentacle issues near the base of the under arm spine, and is covered, except at base of arm, by a very small spine-like scale. The skin of the disk and base of arms is thick, and obscures the finer lines. Colour in alcohol, grey.

Station 156; 1975 fathoms.

Ophiopleura.

Ophiopleura, Danielssen, Magazin for Naturvid., 1877.

Disk notched and covered with fine scales and radial shields, which are widely separated. Numerous mouth papillæ on a prolonged mouth angle. The pores of the second mouth tentacles are like slits, are surrounded by numerous scales and open diagonally into the mouth slits. The jaw plate is set along its whole height with tooth papillæ. Two genital openings in each interbrachial space, midway between the mouth shield and the disk margin. Numerous tentacle scales on the basal pores. Arm spines minute. Side arm plates meeting below but not above. Upper arm plates wide.

Species of *Ophiopleura* not herein described.

Ophiopleura borealis, Danielssen, Magazin for Naturvid, p. 33 (of separate copy), tab. v. figs. 1–4, 1877.

63° 5′ N., 30° E.; 510 to 570 fathoms.

Ophiopleura arctica, Duncan, Ann. Mag. Nat. Hist., vol. ii., part 9, p. 266, 1878.

Lütkenia arctica, Duncan, Ann. Mag. Nat. Hist., vol. ii., part 8, p. 188, pl. ix. figs. 1–7.

Discovery Bay.

Ophiernus.

Ophiernus, Lym., Bull. Mus. Comp. Zool., vol. v., part 7, 1878.

Central portion of disk inside radial shields covered by a thick skin; round the margin a broad band of scaling, interrupted only by radial shields, and covering also the lower interbrachial space, the whole more or less hidden by the skin. Radial shields naked. Teeth, and small, numerous, close-set mouth papillæ. First under arm plate rather large, and bearing some of the scales of the second pair of mouth tentacles. Upper arm plates covering the whole width of arm. Small smooth arm spines, arranged along outer edge of side arm plate. Two large, long genital openings in each interbrachial space.

In the size and function of the first under arm plate, and in the size and shape of the upper arm plates, this genus has a slight relation to *Ophioglypha*.

The disk scaling and skeleton are light and friable, except the marginal scales and radial shields. In its centre, the covering of the upper disk has only a lime-crust, broken, but not divided into regular plates and scales. Teeth large and thick. The peristomial plate is in one piece and thin. The flattened genital plate has attached to its outer end, just at the articulation with the short, circular, radial shield, a very thin scale. The arm

bones are light, with thin wings, and the tops of those next the disk margin have a small process on the outer side. (See Pl. XXXVIII. figs. 6–9.)

Ophiernus vallincola, Lym. (Pl. XXIV. figs. 16–18; Pl. XXXVIII. figs. 6–9).

Ophiernus vallincola, Lym., Bull. Mus. Comp. Zool., vol. v., part 7, p. 122, pl. v. figs. 170–172, 1878.

Three small cylindrical pointed arm spines, less than half as long as an arm joint, set close together and low down on side arm plate; mouth shields rounded and widely separated.

(Type specimen from Station 78.) Diameter of disk 9 mm. Length of arm about 50 mm. Width of arm close to disk, without spines 1·7 mm. Four small, short, rounded, bead-like mouth papillæ on either side of the mouth frames, and usually two at apex under teeth, which are four in number, large and flat, with a rounded cutting edge; besides these there are two little papillæ on the side mouth shield and two on the first under arm plate, which may be considered scales of the second pair of mouth tentacles. Mouth shields triangular, length to breadth about equal, with blunt angle inward, and outer corners rounded. Side mouth shields short, broad without, pointed within, lying on lateral sides of mouth shield, by which they seem widely separated, but the inner narrow points run under the thick skin, and nearly meet within. First under arm plate triangular, with inner angle truncated, lateral sides re-enteringly curved, and outer edge rounded; the rest are narrow and rudely pentagonal, those near base of arm having the inner angle truncated, and the outer slightly curved; inner laterals bounded by a re-entering curve; length to breadth ·8 : ·8. Side arm plates broad and flat, not meeting below, separated above by the broad upper arm plates, which are much wider than long, and cover the whole upper surface of arm, having the lateral sides nearly straight, and edge with a slightly re-entering curve. Disk flat and round; central portion covered with a thin, naked, cross-wrinkled skin; along the margin are minute scattered granules, which, with the thick skin, hide the underlying scales. Radial shields longer than broad, much rounded, widely separated; length to breadth 2 : 1·5. Lower interbrachial space covered with a thin skin, on which there is a very scattered granulation. Genital openings wide, extending from mouth shield to edge of disk. Genital scale not seen. Three small, tapering, cylindrical arm spines, less than half as long as an arm joint, set low on the outer edge of side arm plate. Two small rounded scales on the interbrachial edge of each tentacle pore. Colour in alcohol, greenish grey.

This species grows to a large size; one with a disk of 20 mm. was similar to the above, except that the mouth angle was narrower and more prolonged, and bore, on each side of the mouth frames, eight small, very close-set papillæ. The granulation of the disk was feeble; in many specimens it is wholly wanting. The pair of small mouth papillæ under the teeth is often wanting.

Station 78.—July 10, 1873; lat. 37° 24′ N., long. 25° 13′ W.; 1000 fathoms; globigerina ooze. Station 146.—December 29, 1873; lat. 46° 46′ S., long. 45° 31′ E; 1375 fathoms; globigerina ooze. Station 156.—February 26, 1874; lat. 62° 26′ S., long. 95° 44′ E.; 1975 fathoms; diatom ooze.

Ophiopyrgus.

Ophiopyrgus, Lym., Bull. Mus. Comp. Zool., vol. v. part 7, 1878.

Disk high and dome-shaped, covered with thick swollen plates, and surmounted by a central primary plate, which rises like a cone. Arms slender, smooth, and tubular, with side arm plates very large, and upper and under arm plates small. Basal tentacle pores very large; those beyond small and situated near sides of arm. An arm comb. Arm spines minute, and standing on outer edge of side arm plate. Two long genital openings in each interbrachial space.

This is the most singular-looking genus yet found among the Ophiuridæ. With its peg-like central primary plate and dome-like disk it suggests a simple armed Crinoid whose head has been broken from the stem. By its heavy, closely soldered plates and peculiar tentacle pores, it recalls *Ophiomusium;* by its enclosed mouth tentacles and arm comb, it brings to mind the deep-sea *Ophioglyphæ*, but it differs pretty widely from both.

Ophiopyrgus wyville-thomsoni, Lym. (Pl. IX. figs. 15–17).

Ophiopyrgus wyville-thomsoni, Lym., Bull. Mus. Comp. Zool., vol. v., part 7, p. 121, pl. v. figs. 135–137, 1878.

One minute arm spine on basal joint; farther out, none; a double arm comb over top of arm, the upper one consisting of three or four small papillæ on edge of outer end of genital scale; the under, likewise of three or four papillæ, on edge of side arm plate. Interbrachial space below wholly filled by mouth shield.

Diameter of disk 4 mm; height of disk 4·3 mm; length of arm 13 mm.; width of arm 1·2 mm. Mouth papillæ small, similar, separated, tooth-like; seven or nine to each angle, whereof the innermost is slightly largest. Mouth shields longer than broad, oval, with a peak inward, occupying the entire interbrachial space below, and bending upwards to half the height of arm. Side mouth shields very small and sunken, meeting within, and covering only the inner peak of mouth shields. First under arm plate very long axe-shape, with a curved edge outward and a long, tapering point inward, compressed between two large oval tentacle pores; second plate similar, but smaller; third and fourth plates shorter and still smaller; beyond which the plates are represented by a small knot of a transverse diamond-shape, and growing rapidly less towards end of arm. Side arm plates large, but not swollen, meeting widely above and below, occupying most of the arm, which acquires thereby a tubular, rapidly tapering form. The side arm plates belonging to second under plate are wide, and stretch laterally to meet the mouth shield. Disk as

high as wide, rising in a steep dome surmounted by a sugar-loaf projection, which is the central primary plate, and is surrounded by five other primaries, longer than broad, and hexagonal, outside which are small, angular, radial shields, which are joined; in the interbrachial space, are one pentagonal and one rounded hexagonal plate, the latter joining the upper edge of the mouth shield; all the plates are closely soldered, slightly swollen, and, as well as the arm plates, are microscopically tuberculous. The only genital openings seem to be at the inner end of the mouth shields. One minute peg-like arm spine, which is found only on the first two or three joints beyond disk, and stands half-way up the side arm plate. The second pair of mouth tentacles protrude from very large oval pores covered with four flat rounded scales; the next pores, those of the first arm tentacles, are similar but smaller; the next still smaller, while those of the fourth under arm plate are little round holes covered by a single scale. Farther out on arm the pores lie behind and above the rudimentary under arm plate. Colour in alcohol, white.

The large side arm plates and few disk plates suggest that this is a young animal. Unfortunately the depth is given as 18 and 240 fathoms; but the character of the animal seems to indicate the latter depth.

Station 172.—July 22, 1874; off Nukualofa, Tongatabu; 18 and 240 fathoms; coral, sand.

Ophioglypha.

Ophioglypha, Lym. Proc. Bost. Soc. Nat. Hist., vol. vii., 1860.

Disk covered with plates, or scales, which are usually swollen. Radial shields naked and swollen. Teeth. No tooth papillæ. Mouth papillæ long within, but small and short near the outer end of the mouth slit, and partly hidden by the scales of the mouth tentacles. Arm spines smooth and short, rarely exceeding the length of a joint. Tentacle scales numerous; the innermost pair of tentacle pores shaped like slits, surrounded by numerous tentacle scales, and opening diagonally into the mouth slits. In the back of the disk, where the arm joins it, a notch usually edged with papillæ. Two genital slits starting from the sides of the mouth shields.

Seen from within the upper disk is covered by coarse, irregular, overlapping scales, or plates, and very large, swollen radial shields, which are joined to stout club-ended genital plates whose shaft is flattened and rounded. The genital scale is usually wide, especially at its outer end, which bears the comb and often overlaps the head of the genital plate. In *Ophioglypha hexactis*, however, and probably in other species which have no arm comb, it is long and narrow. The jaws and mouth frames are stout and have large sockets for mouth tentacles, and a nerve ring more or less exposed by reason of the small size of the peristomial plates, which are sometimes represented only by a thin lime crust, and are sometimes nearly or quite wanting. On their outer and inner faces the arm bones present the typical structure, except that they are as high as, or

even higher than wide. In profile, however, they are seen to be longer than the typical form, and present sundry crests and grooves. *Ophioglypha bullata* heads an aberrant group which in some points approaches *Ophiomusium*, to wit, in the closely joined radial shields; the very long and spreading mouth frames, with a broad, regular, uncovered nerve ring; the massive and closely soldered disk plates, and the regular and less club-ended genital plates. (See Pl. XXXVIII. figs. 10–13, 14–17, 22–25.)

Table of Species of *Ophioglypha*.

Disk rather flat, and covered with imbricated scales. Under arm plates small, widely separated; much wider than long beyond the second plate, and thereafter constantly diminishing in size. Arm comb of more or less needle-like papillæ. Arm slightly flattened, with spines about as long as a joint. Tentacle scales few beyond the second pair of pores. (This is the typical form of the genus based on *Ophioglypha ciliata*.

Very large lyre-shaped mouth shields. Pairs of pores between basal under arm plates,	*Ophioglypha ciliata.*
Similar to the preceding, but fewer tentacle scales, and a depression instead of a pair of pores between basal under arm plates,	*Ophioglypha sinensis.*
One depression only between 1st and 2nd under arm plates. Mouth shields larger, and disk thicker than in *Ophioglypha sinensis*,	*Ophioglypha kinbergi.*
No depression between basal under arm plates. Papillæ of arm comb short, spaced, and tooth like. Mouth shields pentagonal, and as broad as long,	*Ophioglypha albida.*
Similar to the preceding, but papillæ of arm comb squarish and crowded, and a slight lobe on outer side of under arm plate,	*Ophioglypha acervata.*
Disk scales more or less swollen. Two tentacle scales on each pore beyond disk,	*Ophioglypha sarsii.* *Ophioglypha arctica.*
Similar to the preceding, but papillæ of arm comb are squarish and crowded, and there is no second comb on basal upper arm plate,	*Ophioglypha lütkeni.*
Primary plates very large and conspicuous, and separated by small scales. Under arm plates minute, and about as long as broad,	*Ophioglypha affinis.*
Disk thick. Outer ends of genital scales separated by a pair of plates bearing papillæ like the arm combs,	*Ophioglypha carnea.*
Disk scales small, regular, and nearly of a size. Papillæ of arm comb short, and almost bead like,	*Ophioglypha robusta.*
Similar to the preceding, but arm spines shorter, disk scales more swollen, and mouth papillæ smaller,	*Ophioglypha meridionalis.*
Upper disk scales with a central depression. Lower arm spine in form of a hook,	*Ophioglypha falcifera.*
Disk covered by a few large plates, whereof the primaries occupy the area inside the radial shields. Three short, stumpy, arm spines,	*Ophioglypha forbesii.*
Disk covered with smooth skin, through which the very small scales are scarcely or not at all visible. Arm spines, long, broad, and flat,	*Ophioglypha flagellata.*
Disk scales thin and smooth. Under arm plates, within disk, large and touching each other. Arm comb of sharp needle-like papillæ, with a well-marked under comb on the arm itself,	*Ophioglypha palliata.*

Table of Species of *Ophioglypha*—continued.

Disk thin, with rather delicate scales, arms slender, with small spines. Papillæ of arm comb sharp and cylindrical.	Four arm spines; one long and high up, three short and low down. Radial shields touching without; disk scales angular,	*Ophioglypha lepida.*
	Three arm spines; one long and high up, two short and low down. Radial shields separated; disk scales small and curved,	*Ophioglypha ljungmani.*
	Four very short, peg-like arm spines equally spaced,	*Ophioglypha æqualis.*
	Three slender, equally spaced arm spines. Mouth shield trefoil, with a long lobe inward,	*Ophioglypha imbecillis.*
Disk covered with smooth, moderately thick scales. Arm spines small and short. Second under arm plate about as long as broad, those farther out much broader than long. Papillæ of arm comb close-set, flat, and with rounded ends.	Three very short, small, sharp arm spines, low down. Mouth shield wider than long, with a point within. Radial shields long and separated,	*Ophioglypha irrorata.*
	Three very short, small, sharp arm spines, low down. Mouth shield as broad as long. Radial shields short, rounded, and separated by the fine scaling of the disk,	*Ophioglypha orbiculata.*
	Three very short conical arm spines, standing on middle of edge of plate. Disk scales coarse and rather thick. Radial shields broader than long, and joined,	*Ophioglypha undulata.*
	Three very short, blunt, peg-like arm spines, evenly spaced. Disk scales few and large. Radial shields long and separated,	*Ophioglypha costata.*
	Similar to the preceding, but the upper arm plates form a ridge, while they are flat in *O. costata*,	*Ophioglypha lymani*
	Six short, blunt, peg-like, evenly spaced arm spines. Arms narrow. Radial shields short, and separated by one or two large rounded plates,	*Ophioglypha albata.*
	Three slender pointed arm spines, about two-thirds as long as a joint. Disk scales few and mostly large. Radial shields large and joined,	*Ophioglypha jejuna.*
Disk scales of moderate size, thick, and swollen. Very small, narrow, side mouth shields. Arm spines short. Tentacle scales numerous. Under arm plates within disk about as broad as long, and separating the side arm plates.	Three short, blunt, peg-like arm spines, evenly spaced. Papillæ of arm comb short, close-set, and sharp,	*Ophioglypha brevispina.*
	Four short, blunt, peg-like arm spines, three together low down, and one higher up. Papillæ of arm comb short, close-set, and squarish,	*Ophioglypha ambigua.*
Disk smooth and flat, with scales, radial shields, and mouth shields all small. Arm spines few and small. Mouth papillæ and tentacle scales similar, numerous, even, and close set.	Three to five short, sharp arm spines, about half as long as a joint,	*Ophioglypha loveni.*
	Five very minute, blunt arm spines, which are often rubbed off or naturally wanting,	*Ophioglypha fraterna.*

Table of Species of *Ophioglypha*—continued.

- Six arms. No arm comb. Radial shields almost wholly covered by fine smooth scaling of disk. Upper arm plates with numerous supplementary scales on either side, ... → *Ophioglypha hexactis.*

- Disk high and arched. Arms short and thick, not more than twice diameter of disk. Basal side arm plates meeting neither above nor below. (Type of *Ophioglypha nodosa.*)
  - Three rudimentary arm spines. Under arm plates squarish, with rounded corners, ... → *Ophioglypha nodosa.*
  - Eight short, papilla-like, unequal arm spines. Under arm plates 4-sided, with curved lateral sides. They are marked with short furrows, . → *Ophioglypha sculpta.*
  - Eleven very short, papilla-like, unequal spines; besides which some plates bear long supplementary spines on their sides. Under arm plates 4-sided, with lateral sides curved, ... → *Ophioglypha sladeni.*
  - Disk covered by small scales, and small sunken radial shields. Arm spines minute like flat papillæ, and fitting into little notches in inner edge of the succeeding side arm plate, . . . → *Ophioglypha striata.*
  - Under arm plates with a raised keel. Seven tentacle scales and arm spines which are similar, continuous, and rudimentary. Arm comb papillæ minute and blunt, ... → *Ophioglypha stuwitzii.*
  - Under arm plates with a raised keel. Five spaced arm spines. Papillæ of arm comb sharp and slender, ... → *Ophioglypha elevata.*

- Disk high. Basal under arm plates about as long as broad. Arms high and rounded, with very short spines. Side arm plates not meeting below within disk. Side mouth shields small, and at inner point of mouth shield. Many tentacle scales. (Type of *Ophioglypha bullata.*)
  - Interbrachial space below, covered almost entirely by the large mouth shields and genital scales.
    - Three minute, evenly spaced arm spines. Disk scales above rounded and of various sizes, with large marginal plates, ... → *Ophioglypha bullata.*
    - Three small tapering arm spines. Disk covered above by a rosette of large angular primary plates, radial shields, and a few large interbrachial plates, ... → *Ophioglypha convexa.*
  - Mouth shield and genital scales large and conspicuous, but not covering the central margin of the interbrachial space.
    - Six minute arm spines. First under arm plate broader than long; those beyond longer than broad. Radial shields separated within by a cluster of large scales, ... → *Ophioglypha sculptilis.*
    - Four or five minute arm spines. Under arm plates longer than broad. Radial shields separated at inner ends by a single scale, . . . → *Ophioglypha variabilis.*
    - Three or four minute, widely spaced arm spines. Mouth shield trefoil, with a pointed lobe inward, ... → *Ophioglypha ornata.*
    - Three minute arm spines, high up. Radial shields rounded, separated by one scale within. One large marginal plate with small scales about it, . → *Ophioglypha lacazei.*
  - Three minute arm spines. Disk covered by small irregular scales, small separated radial shields, and very large mouth shields, . . → *Ophioglypha lienosa.*
  - Two minute arm spines. Mouth shield trefoil. Under arm plates axe-shape. Radial shields small and rounded, ... → *Ophioglypha radiata.*
  - Four minute, blunt, arm spines. Disk plates rough and lumpy, with rosette of large primaries. Under arm plates pentagonal, . . → *Ophioglypha undata.*
  - Eleven short, pointed, close-set arm spines. Mouth shields trefoil. Under arm plates squarish. About eight tentacle scales to each pore within the disk, ... → *Ophioglypha lapidaria.*

Table of Species of *Ophioglypha*—continued.

Papillæ of arm comb continued along outer ends of the large radial shields, and on the margin of the inserted upper arm plate. Large depressions between basal under arm plates,	*Ophioglypha multispina.*
Basal under arm plates, beyond the second, about as long as broad, squarish, and with water pores between them. Arms high, with swollen upper arm plates and very small spines. Upper disk covered in great part by a rosette of primary plates and by radial shields,	*Ophioglypha solida.*
Disk covered with much-swollen lumpy plates. Genital scales wide, thick, and in a single piece. Basal under arm plates longer than wide. Papillæ of arm comb short, flat, close-set, and with rounded ends,	*Ophioglypha rugosa.*
Disk plates high and excessively swollen. Upper arm plates rising in a high sharp ridge. Arm spines minute, close-set, and like little blocks,	*Ophioglypha ponderosa.*
Interbrachial space below covered by only one or two plates besides the genital scales. Upper arm plates rudimentary or wanting. Tentacle pores of arm with only one rounded scale,	*Ophioglypha minuta.*
Disk thick, and covered with thin smooth scales. No arm comb nor papillæ along genital openings. Basal under arm plates, beyond the second, short and wide,	*Ophioglypha inermis.*
Disk and arm plates thick, swollen, and closely soldered. Mouth papillæ and scales of mouth tentacles thick, squarish, irregular, and crowded. Arm spines minute, with tentacle scales similar in form, and standing only on side arm plate, inside the pore. — No true arm comb. — Side mouth shields large and ovoid. Radial shields and primary plates circular and similar,	*Ophioglypha deshayesi.*
Side mouth shields small. Mouth shield broader than long, with a peak inward,	*Ophioglypha inornata.*
Disk plates irregular and humpy. A group of papillæ near the arm, on margin of interbrachial space,	*Ophioglypha confragosa.*
A small arm comb. Side mouth shields very narrow,	*Ophioglypha intorta.*

Ophioglypha sinensis, Lym., Ill. Cat. Mus. Comp. Zool., No. vi. p. 12, pl. i. figs. 1, 2, 1871; Bull. Mus. Comp. Zool., vol. v., part 7, p. 99, 1878.

Off Yokohama, Japan; 8 to 15 fathoms. Station 233*b*.—May 26, 1875; lat. 34° 20′ N., long. 133° 35′ E.; 15 fathoms; mud.

Ophioglypha kinbergi, Ljn. (Pl. IV. fig. 7).

Ophioglypha kinbergi, Ljn., Om Några nya arter, Öf. Kong. Akad., p. 166, 1866.
Ophioglypha ferruginea, Lym., Bull. Mus. Comp. Zool., vol. v. part 7, p. 68, pl. iii. fig. 76.

Disk rather flat and covered with imbricated scales. Under arm plates small, widely separated; much wider than long beyond the second plate, and thereafter constantly diminishing in size. Arm comb of papillæ more or less needle-like. Arm slightly flattened with spines about as long as a joint.

(Type specimen from Station 162.) Diameter of disk 6·5 mm. Length of arm about 22 mm.; width of arm close to disk without spines 1·5 mm. Three or four short, pointed, widely separated papillæ on each side, and one or two, somewhat longer, at apex of jaw. Mouth shields longer than wide, pentagonal, with an angle inward, lateral sides straight, outer edge rounding, length to breadth 1·7 : 1. Side mouth shields nearly straight and narrow, slightly tapering inward, where they meet. First under arm plate triangular, with an angle inward and outer edge curved; second one with lateral sides curved; those beyond are much broader than long, with curved outer edge and a small peak within. Side arm plates slightly swollen, meeting broadly below, separated above by upper arm plates, four sided, with outer edge rounded, lateral sides straight, and inner side shorter than outer. Disk covered with closely-joined, rounded scales of several sizes; radial shields short, pear-seed shape, swollen, nearly meeting without, but separated throughout their entire length by a wedge of one large and three or four smaller scales; space within the radial shields occupied by a central cluster of six primary plates, separated by minute scales, one or two larger plates in the brachial and interbrachial spaces, with other smaller ones irregularly disposed. Genital scales long and narrow; along their free edge is a line of very fine bead-like papillæ, becoming short regular spines as they pass to the upper surface to form the arm comb, where the genital scales are much broader; interbrachial spaces below covered with rows of semicircular swollen plates, varying in size; at the margin is a large, much swollen plate, broader than long, on either side of which is a smaller oval one. Three long tapering arm spines, the upper one being slightly longer than the others, and nearly as long as a joint. Tentacle scales thin, and quite round,—on the large pores of the mouth tentacles four or five on each side; on the second, three on each side; third and fourth, two on each side; those beyond have usually one large scale. Colour in alcohol, below, white; above, mottled yellowish-brown, and arms barred with the same.

Ophioglypha kinbergi, is of the strictly typical Ophioglyphæ. It is distinguished from *Ophioglypha sinensis* by different mouth shields and thicker disk scales, and by wanting the water pores between the basal under arm plates.

A more careful examination of an original of *Ophioglypha kinbergi* satisfies me that the *Ophioglypha* described by me as *Ophioglypha ferruginea* is a variety only.

Station 162.—April 2, 1874; off East Moncœur Island, Bass Straits; 38 fathoms; sand. Port Jackson; 2 to 10 fathoms; sand. Station 161.—April 1, 1874; off entrance to Port Philip; 38 fathoms; sand. Station 188 (Var. ?).—September 10, 1874; lat. 9° 59′ S., long. 139° 42′ S.; 28 fathoms; mud.

Ophioglypha acervata, Lym., Bull. Mus. Comp. Zool., vol. i. part 10, p. 316, 1869; Ill. Cat. Mus. Comp. Zool., No. vi., pl. i. fig. 6; Bull. Mus. Comp. Zool., vol. v. part 7, p. 99; Bull. Mus. Comp. Zool., vol. v., part 9, p. 218.

Station 122.—September 10, 1873; lat. 9° 5′ S. to 9° 10′ S., long. 34° 49′ W. to 34° 53′ W.; 350 fathoms; mud.

Ophioglypha sarsii, Lym., Ill. Cat. Mus. Comp. Zool., No. i. p. 41, figs. 2, 3; Bull. Mus. Comp. Zool., vol. v. part 7, p. 99; Ludwig, Anatomie der Ophiuren, Zeits. für wissen. Zoologie, vol. xxxi. p. 241.

Ophiolepis ciliata, Stimp., Invert. Gr. Manan; Smith, Contrib., vol. vi. p. 13, 1854.
Ophiura coriacea, Ltk., Vid. Meddel., Nov. 1854, p. 7.
Ophiura sarsii, Ltk., Vid. Meddel., Nov. 1854, p. 7; Addit. ad Hist., part 1, p. 42, pl. i. figs. 3, 4.

Station 49.—May 20, 1873; lat. 43° 3′ N., long. 63° 39′ W.; 83 fathoms; gravel, stones.

Ophioglypha meridionalis, Lym.

Ophioglypha meridionalis, Lym., Bull. Mus. Comp. Zool., vol. vi., part 2, p. 56, pl. xvi. figs. 447–449, 1879.

Disk rather flat, covered with large imbricated scales. Arm comb of minute bead-like papillæ, scarcely to be seen above, but continuous along edge of genital scale. Three peg-like arm spines less than half as long as a joint. Only one tentacle scale beyond the mouth tentacles.

(Type specimen from Station 320.) Diameter of disk 4 mm. Length of arm about 12 mm. Width of arm close to the disk ·7 mm. Five small, short, broad, flat, close-set mouth papillæ on each side of the mouth angle, and one pointed and similar to the teeth at the apex. Mouth shields somewhat swollen, about as broad as long, with a curve without and an obtuse angle inward. Side mouth shields short, straight, meeting by their full width within, occupying only the inner angle of mouth shield. First under arm plate blunt heart shaped, quite as large as, or larger than, the second, which is pentagonal, with inner angle truncated, outer side gently curved, and laterals re-enteringly curved; one-third out on the arm the under plates are small, much wider than long, bounded by a broad curve without and with a little peak inward. Side arm plates large and thick, meeting broadly below beyond the second arm plate, and touching above beyond the third plate. Upper arm plates long, wedge shaped, with a clean curve outward and a sharp angle within. Disk rounded, rather flat and only a little arched above, covered by large slightly swollen scales, whereof the primary plates form a conspicuous rosette, radiating from which there usually is, in each interbrachial space, a row of three overlapping scales. Radial shields as broad as long, sunken, rounded, with a faint angle inward; joined without, separated by a wedge scale within; they are smaller than the large disk scales. Below, the scales are similar, eight or nine in each interbrachial space. Papillæ along edge of genital scale minute, bead-like, and continuous; only one or two, and sometimes

none, can be seen from the upper surface. Three small, nearly equal, peg-like arm spines, less than half the length of a side arm plate. Five small, close-set tentacle scales to pores of mouth tentacles, three on one side and two on the other; the pores beyond have but one small rounded scale. Colour in alcohol, straw.

Station 317.—February 8, 1876; lat. 48° 37′ S., long. 55° 17′ W.; young; 1035 fathoms; hard ground. Station 320.—February 14, 1876; lat. 37° 17′ S., long. 53° 52′ W.; 600 fathoms; hard ground.

The specimen described, though well characterised, was perhaps not fully grown. It is the southern cousin of *Ophioglypha robusta*, from which it differs in shorter arm spines, more swollen disk scales, smaller mouth papillæ, and fewer tentacle scales.

Ophioglypha multispina, Ljn., Oph. Viv. Öf. Kong. Akad., p. 307, 1866; Lym., Bull. Mus. Comp. Zool., vol. v., part 7, p. 99.

Port Jackson, Australia; 2 to 10 fathoms.

Ophioglypha hexactis, E. A. Smith (Pl. XLV. fig. 1; Pl. XLVII. fig. 2).

Ophioglypha hexactis, E. A. Smith, Ann. Mag. Nat. Hist., vol. xvii. p. 3, Feb. 1876; Lym., Bull. Mus. Comp. Zool., vol. v., part 7, p. 99.

In the whole genus this is the only species that has more than five arms. It is also viviparous. A curious parallel is the many-armed *Ophiacantha vivipara*, from the same region, which is viviparous likewise. But whereas the bursæ of the latter are limited to the neighbourhood of the arms, those of the species under consideration are thrust between the disk roof and the digestive cavity, until in some cases they occupy almost the whole body cavity proper, a state of things shown in fig. 1, Plate XLV., which presents a vertical cross-cut of a gravid female, passing through one arm and the opposite interbrachial space. Just above the mouth angles is the long fold of the mouth sphincter (*du*), continued on either side by a wide flattened somewhat pleated digestive cavity, whose walls are thin and membranous in some places, where their soft layer has been scraped off. Above this is a space like the low between-decks of a ship, wherein are stored the large young, two of which (Y,Y′) are seen cut in two, together with parts of their arms. One (Y) is in a natural position, while the other (Y′) lies on its back. Both show the mouth angles beginning to take form, and the large mouth tentacles. Their digestive cavities, simple in the adult, are folded in a way that calls to mind *Gorgonocephalus*. At first sight these young seem lying free in the body cavity. Each, however, is enclosed in a thin bag, an expansion of the bursa (a fold of it is seen at δ′), which has thrust itself between the disk roof and the upper wall of the digestive cavity. These two surfaces are closely connected normally by threads (*sm*), which in the present case are not broken, but simply stretched, sometimes to an immense extent. The relation of the parts may be made clearer by removing the roof of the disk and showing

from above the young enclosed in their bursæ (Pl. XLVII. fig. 2); or rather, perhaps, in pockets leading out of the bursæ.

Kerguelen Island; 20 to 75 fathoms. Off Marion Island; 50 to 75 fathoms.

Ophioglypha falcifera, Lym., Bull. Mus. Comp. Zool., vol. i., part 10, p. 319, 1869; vol. v., part 7, p. 99; vol. v., part 9, p. 218; Ill. Cat. Mus. Comp. Zool., No. vi., pl. i. figs. 3–5.

Station 24.—March 25, 1873; off Culebra Island; 390 fathoms; mud.

Ophioglypha flagellata, Lym. (Pl. IV. figs. 16–18).

Ophioglypha flagellata, Lym., Bull. Mus. Comp. Zool., vol. v., part 7, p. 69, pl. ii. figs. 49–51.

Disk covered with smooth skin, through which the very small scales are scarcely or not at all visible. Arm spines long, broad, and flat.

(Type specimen from Station 232.) Diameter of disk 18 mm. Width of arm without spines 4 mm. Mouth papillæ, four or five on each side, small, tooth-like, separated, growing larger towards the apex of the jaw, where there is one large and club-shaped resembling the teeth above it. Mouth shield small, short, heart-shaped, with projecting corners and angle inward; length to breadth 2·7 : 3. Side mouth shields long and narrow, wider without than within, where they do not quite meet. First under arm plate broader than long, triangular or rudely hexagonal, with angles much rounded; the plates beyond are much wider than long, bounded within by a blunt angle and without by a curve having a little peak at its apex. Side arm plates rather thin, not meeting till some way beyond disk, widely separated above by upper arm plates, which are hexagonal, much broader than long, very flat and thin, with outer and inner edges straight, and ill-marked lateral angles. Disk flat, covered with a thick skin, under which the thin small scales are scarcely, or not at all, distinguishable. Radial shields very small, rounded, and widely separated; length to breadth 1 : 1·5. Interbrachial spaces below covered by regular rows of very fine, minute scales, extending quite to the margin. Genital scales long and very narrow, almost concealed by the disk scales; along the free edge is a row of very fine, delicately pointed papillæ, which grow longer as they pass upward to make a short arm comb. Arm spines longer than the joints, flat spatula shape, arranged in a cluster of three just outside the tentacle pores; of which those of the mouth tentacles are very large, and have six or seven thin, flat scales on each side; the next three have three long, thin flat scales on the inner side, and one or two very small slender ones on the outer side; beyond this, three only, on the inner side. Colour in alcohol, disk grey, upper arms yellowish-brown.

Station 232.—May 12, 1875; lat. 35° 11′ N., long. 139° 28′ E.; 340 fathoms; sandy mud.

Ophioglypha palliata, Lym. (Pl. IV. figs. 4–6).

Ophioglypha palliata, Lym., Bull. Mus. Comp. Zool., vol. v., part 7, p. 69, pl. iv. figs. 98–100.

Disk scales thin and smooth. Under arm plates, within disk, large, and touching each other. Arm comb of sharp needle-like papillæ, with a well-marked under comb on the arm itself.

(Type specimen from Station 164*a*). Diameter of disk 10·5 mm. Width of arm close to disk 2·5 mm. Five or six small mouth papillæ on each side, the two outermost being short and blunt, the next three or four sharply pointed, while the one at the apex of the jaw is large and rounded at the end. Mouth shield pentagonal with a blunt angle inward, and outer corners rounded. Length to breadth 2·5 : 2. Side mouth shields long and narrow, meeting within; broadest at their outer end, where they join the side arm plates. First under arm plates irregular, transverse oval; the second similar, but larger; those immediately beyond are transverse diamond shaped, with much rounded angles. Side arm plates broad and thin, not meeting below till beyond the disk, widely separated above by the upper arm plates, of which the first one is small and triangular, the second quadrangular, with the outer edge widest and curved, and inner edge straight. Upper surface of disk, which is smooth and even, covered with thin, fine, ill-defined curved scales; the radial shields are longer than wide, with edge much rounded, separated their entire length by small scales. Under surface covered by rows of scales somewhat larger than those above. Genital scales wholly covered by the scaling, except above, where they support an arm comb of sharp, slender papillæ; their free edge below carries a row of small conical papillæ. Three tapering arm spines, upper one longest, second and third about equal. Three or four small rounded tentacle scales on each side of the mouth tentacles, second and third pores having three on each side; those just beyond with four short sharp scales on the inner side. Colour in alcohol, grey.

Station 164*a*.—June 13, 1874; lat. 34° 13′ S., 34° 19′ S., long. 151° 38′ E., 151° 31′ E.; 400 fathoms; blue mud.

Ophioglypha lepida, Lym. (Pl. IV. figs. 1–3).

Ophioglypha lepida, Lym., Bull. Mus. Comp. Zool., vol. v., part 7, p. 70, pl iii. figs. 71–73.

Four arm spines; one long and high up, three short and low down. Radial shields touching without; disk scales angular. Disk thin, with rather delicate scales. Arms slender.

(Type specimen from Station 46.) Diameter of disk 9 mm. Width of arm close to disk 1·5 mm. Mouth papillæ, three to four on each side, short and square, with a larger pointed one at apex of jaw. Mouth shield wide pentagonal, with an obtuse angle inward, outer edge slightly curved, and outer corners rounded; length to breadth 1 : 1. Side mouth shields long narrow, wider without, tapering inward where they meet. First under arm plate broad triangular, those beyond pentagonal, with obtuse angle inward, lateral sides re-enteringly curved and outer edge slightly curved; beyond the disk they gradually

acquire the shape of a transverse oval, with a little peak without and within. Side arm plates even, giving a tubular figure to the arm, meeting below, but separated above by the upper arm plates, which are as long as broad, and in shape long hexagonal, with the three outer angles almost blended in a curve. Disk smooth, covered with small, delicate, irregular, ill-defined, closely-soldered scales; radial shields long, pear-seed shape, overlapped along their edges by the surrounding scales, diverging inward and separated their entire length by a wedge of smaller and larger scales; in centre of disk one large round primary plate, and another in each brachial space, lying close to inner ends of radial shields. Disk, below, covered with very fine irregularly-shaped scales. Genital openings edged with fine, closely-set papillæ, growing larger as they pass upwards along the outer edge of genital scale, which is long, narrow within, broad without, and divided in several pieces. Three short and blunt arm spines, situated low on the side arm plates, close to the tentacle pores, and one long tapering spine, just below the junction of the upper arm plate. Tentacle scales short and rounded; to each mouth tentacle seven on the interbrachial side, and three longer and tapering on the brachial edge; beyond there are at first five on the interbrachial and four on the brachial edge, after which they diminish rapidly in number and size. The long arm spine readily drops off. Colour in alcohol, grey.

Ophioglypha lepida and its kindred species form an intermediate type between the shallower, like *Ophioglypha albida*, and the deep-sea, of which *Ophioglypha bullata* is the extreme.

Station 46.—May 6, 1873; lat. 40° 17′ N., long. 66° 48′ W.; 1350 fathoms; mud. Off Bermuda; 750 fathoms. Station 76.—July 3, 1873; lat. 38° 11′ N., long. 27° 9′ W.; 900 fathoms; globigerina ooze. Station 45.—May 3, 1873; lat. 38° 34′ N., long. 72° 10′ W.; 1240 fathoms; mud. Station 343.—March 27, 1876; lat. 8° 3′ S., long. 14° 27′ W.; 420 fathoms; coral.

Ophioglypha ljungmani, Lym. (Pl. IV. figs. 8–10).

Ophioglypha ljungmani, Lym., Bull. Mus. Comp. Zool., vol. v., part 7, p. 71, pl. iii. fig. 77.

Three arm spines; one long and high up, two short and low down. Radial shields separated; disk scales small and curved. Disk thin, with rather delicate scales. Arms slender.

(Type specimen from Station 122.) Diameter of disk 8·5 mm. Length of arm about 45 mm.; width of arm without spines close to disk 2 mm. Four or five short flat mouth papillæ on each side, and one or two longer pointed papillæ at apex of jaw. Mouth shield rounded, triangular, or inclining to rounded-pentagonal, with an angle inward, longer than broad, outer edge curved. Side mouth shields very narrow, wider without, tapering within, where they nearly or quite meet. First under arm plate broad triangular, with lateral corners truncated and outer edge curved; second, third, and fourth plates widely pentagonal, with an angle inward; beyond these they are small, broader than long, with an obtuse angle inward and a curved outer edge. Side arm plates slightly projecting at their outer edge, meeting broadly below beyond the disk; separated above by the upper

arm plates, which are hexagonal, with lateral sides straight and two outer angles nearly blended in a curve. Disk smooth, covered with small irregular plates, but little swollen. Radial shields pear-seed shape, somewhat overlapped by adjoining scales; just touching without, diverging within, where they are separated by two or three small plates. The rest of the upper disk is occupied by numerous scales, among, and separated by which, appears a central cluster of primary plates; in the interbrachial spaces are usually one or more larger plates near the margin of the disk. Genital scales very broad above and without, where they carry an arm comb of fine spines, but buried by disk scales below near the mouth shield; along their lower free edge is a row of minute tooth-like papillæ, between the genital plates and outside the mouth shield. Interbrachial space below covered by irregular overlapping scales. Three slender arm spines, the longest one nearly as long as a joint, and situated near the junction of the side arm plate with the upper, and two others similar but shorter near the junction of the side with the under arm plate. Tentacle scales small, short, pointed, four or five on each side of mouth tentacle pore, whence they diminish in number, till just beyond the disk, where there are two on the inner side of each pore. Colour in alcohol, grey.

It differs from *Ophioglypha lepida* and *Ophioglypha æqualis* in the coarser disk scales. With them it connects the stout deep-sea forms to those of shallow water, like *Ophioglypha albida*.

Station 122.—September 10, 1873; lat. 9° 5′ S. to 9° 10′ S., long. 34° 49′ W. to 34° 53′ W.; 350 fathoms; mud.

Ophioglypha æqualis, Lym. (Pl. IV. figs. 14, 15).

Ophioglypha æqualis, Lym., Bull. Mus. Comp. Zool., vol. v., part 7, p. 72, pl. iii. figs. 74, 75.

Four very short, peg-like arm spines, equally spaced. Disk thin, with rather delicate scales. Arms slender.

(Type specimen from Station 218.) Diameter of disk 10 mm. Width of arm close to disk without spines 1·7 mm. Four or five short, square, separated mouth papillæ on each side, with one much larger and pointed at apex of jaw. Mouth shields broader than long, with outer edge curved, a blunt angle inward and a slight notch in the lateral sides; length to breadth 1·3 : 2. Side mouth shields short and narrow, meeting within. First under arm plate broad triangular, with outer edge curved and a blunt angle inward; second plate broader without than within, pentagonal, with an angle inward, outer edge slightly curved, and lateral sides re-enteringly curved; the rest are broader than long, rapidly becoming smaller in size beyond the disk, where they acquire the shape of a transverse oval, with a little peak within and a curve without. Side arm plates even and of a tubular figure, slightly projecting at their outer edge, meeting widely below, separated above at the basal joints by the upper arm plates, of which the first and second form a wedge with a curved outer edge, filling the notch formed by the arm combs, and bearing

on their lateral sides a row of minute, sharp papillæ; the rest are long, triangular, with the outer edge curved, and a sharp angle inward, which on the second and third plate is truncated. Disk flat and delicate, covered with very thin, small, closely overlapping scales; in the centre is a circular primary plate, surrounded by fine irregular scales, then a circle of five primary plates, one in each brachial space, and separating the inner ends of the radial shields, which are long, pear-seed shape, and separated the rest of their length by small scales; in the interbrachial space there is a row of larger rounded plates, of which the outer one is marginal. Interbrachial spaces below covered with thin overlapping scales. Genital scales long and very narrow where next the mouth shield, but gradually growing wider above the arm, where they make a long arm comb carrying delicate spine-like papillæ; on the free edge of the genital scale below there is a row of very short, minute, rounded papillæ. Four or five minute, blunt arm spines, equally spaced along the edge of the side arm plate. The pores of the mouth tentacles and the two pairs beyond are long and large, and have from four to six small tentacle scales on each side. Those a little beyond the disk have only one scale on the inner side and none on the outer. Colour in alcohol, white.

It is very near *Ophioglypha lepida* except as to arm spines, and basal upper arm plates.

Station 218.—March 1, 1875; lat. 2° 33′ S., long. 144° 4′ E.; 1070 fathoms; globigerina ooze.

Ophioglypha imbecillis, Lym. (Pl. IV. figs. 11–13).

Ophioglypha imbecillis, Lym., Bull. Mus. Comp. Zool., vol. v. part 7, p. 73, pl. iii. figs. 63, 64.

Three slender, equally spaced arm spines. Mouth shield trefoil, with a long lobe inward. Disk thin, with rather delicate, but rough and angular scales. Arms slender.

(Type specimen from Station 232.) Diameter of disk 6·5 mm. Length of arm 20 mm. Width of arm near disk 1 mm. Mouth papillæ four or five on each side, square, short, and closely set, with a pointed one at apex of jaw. Mouth shields trefoil shaped, with a lobe inward; length to breadth 1·5 : 1·5. Side mouth shields curved, long, and narrow, of nearly even width, and meeting within. First arm plate triangular, with angle inward, and outer side curved; second plate, which is largest of all, axe-shaped, with lateral sides re-enteringly curved; the rest are triangular, with outer side curved, and diminish constantly in size. Side arm plates straight and rather delicate, meeting broadly above and below, beyond the second upper arm plate. Upper arm plates triangular, with acute angle inward, and outer edge curved. Upper surface of disk covered with irregular rather thin plates. Radial shields longer than bread; outer edges curved, meeting broadly without, diverging inward, where they are separated by a larger and smaller plate. On the interbrachial margin of the disk is a large oval plate, broader than long, connecting the radial shields; in the centre a circular primary plate, surrounded by numerous others, irregularly shaped. Genital scales long and broad, bearing three or four papillæ near their outer

end. Outside the mouth shield and between the genital scales are two large semicircular plates, whose outer edges reach the margin of the disk. Three arm spines, tapering, very delicate, situated half-way up on the side arm plate, near base of arm; they are about half as long as a joint. Tentacle scales minute and semicircular, two on either side of first two pores; at the third, two on the outer and one on the inner side; for the rest only one. Colour in alcohol, grey.

Station 232.—May 12, 1875; off Enosima; lat. 35° 11′ N., long. 139° 28′ E.; 340 fathoms; sandy mud.

Ophioglypha lymani, Ljn. (Pl. XXXVIII. figs. 10–13).

Ophioglypha lymani, Ljn., Om tvänne nya arter. Öf. Kong Akad., p. 472, 1870; Bull. Mus. Comp. Zool., vol. 7, p. 100.

Station 304.—December 31, 1875; lat. 46° 53′ S., long. 75° 11′ W.; 45 fathoms; sand. Station 305.—January 1, 1876; lat. 47° 48′ S., long. 74° 48′ W.; *120 fathoms*; mud. Station 307.—January 4, 1876; lat. 49° 24′ S., long. 74° 23′ W.; *140 fathoms*; mud. Station 308.—January 5, 1876; lat. 50° 10′ S., long. 74° 42′ W.; *175 fathoms*; mud. Station 309.—January 8, 1876; lat. 50° 56′ S., long. 74° 15′ W.; 40 to 140 fathoms; mud. Station 311.—January 11, 1876; lat. 52° 50′ S., long. 73° 53′ W.; 245 fathoms; mud. Station 313.—January 20, 1876, lat. 52° 20′ S., long. 68° 0′ W.; 50 fathoms; sand.

Ophioglypha irrorata, Lym. (Pl. V. figs. 7–9).

Ophioglypha irrorata, Lym., Bull. Mus. Comp. Zool., vol. v., part 7, p. 73, pl. iv. figs. 106–108, 1878.

Three very short, small, sharp arm spines, low down. Mouth shield wider than long, with a point within. Radial shields long and separated. Papillæ of arm comb close set, flat, and with rounded ends.

(Type specimen from Station 143.) Diameter of disk 8·5 mm. Width of arm close to disk, without spines, 1·7 mm. Six square, close-set mouth papillæ on each side, and one large diamond-shaped at apex of jaw. Mouth shield much broader than long, with outer edge much rounded, and an obtuse angle inward; length to breadth 1·7 : 2. Side mouth shields long and narrow, just meeting within and with a swelling at the outer end. First under arm plate triangular, transverse oval, or wide rounded hexagonal; second plate pentagonal, with inner angle truncated, outer edge rounded and wider than inner one, lateral sides re-enteringly curved; beyond this they are rounded triangular, with a broad curve without, and a peak inward. Side arm plates wide, flat, even; meeting broadly below, beyond third plate separated above by the upper arm plates, which are four-sided, with inner side shorter than outer, which is curved. Disk flat and thin, covered with fine, closely overlapping scales; there are six large round primary plates, one in the centre and one to each brachial space, widely separated by the disk scales; on the surface of the disk are a few scattered, very minute spines. Radial shields irregular

rhomboidal, broad without and with a blunt angle inward, separated their entire length by a wedge of larger and smaller disk scales; length to breadth 2:1. Interbrachial surface on the under side covered with the same fine overlapping scales as above. Genital scales small, narrow within, widening a little without as they appear above the disk. Along their free edge, which extends from outer edge of mouth shield to margin of disk, there is a close row of minute, squarish, tooth-like papillæ, which become short and rounded on the arm comb. Three small pointed arm spines, situated low on the edge of the side arm plate close to the tentacle scales. On the pores of the mouth tentacles five large rounded scales similar to the mouth papillæ, on either side; on the second set six on the interbrachial side and four on the brachial; immediately beyond the disk there are only one or two on the inner and none on the outer side. Colour in alcohol, white.

Station 143.—December 19, 1873; lat. 36° 48′ S., long. 19° 24′ E.; 1900 fathoms; globigerina ooze. Station 164*a*.—June 13, 1874; lat. 34° 13′ S., long. 151° 38′ E.; (young of this species ?); 410 fathoms; grey ooze.

Ophioglypha orbiculata, Lym. (Pl. VIII. figs. 10–12).

Ophioglypha orbiculata, Lym., Bull. Mus. Comp. Zool., vol. v., part 7, p. 74, pl. iv. figs. 103–105, 1878.

Three very short, small, sharp arm spines, low down. Mouth shield as broad as long. Radial shields short, rounded, and separated by the fine scaling of the disk. Papillæ of arm comb close set, flat, and with rounded ends.

(Type specimen from Station 237.) Diameter of disk 15·5 mm. Width of arm close to disk 2·7 mm. Six or seven mouth papillæ on each side, small, irregular, and tooth-like, with three longer and more pointed at apex of jaw. Mouth shield broader than long, five sided, having a broad angle within, with outer lateral corners rounded; length to breadth 2·5 : 2·3 Side mouth shields, following inner angle of mouth shield, narrow, pointed without, and broader within, where they meet. First under arm plate transverse oval, broader than long, often with lateral ends pointed; second arm plate four sided, with corners much rounded; the next three are pentagonal, with an angle inward, and outer edge curved; beyond these the lateral sides become shorter, so that soon the form changes to very wide triangular, with a broad curved outer edge, and an obtuse angle inward. Side arm plates broad, little swollen, meeting below beyond the disk, separated above by upper arm plates, of which the first is oval, with pointed lateral ends; those beyond four sided, broader without than within, outer side curved, lateral sides nearly straight. Disk flat, smooth, and very thin; upper surface covered with small, irregular, closely overlapping scales, with a row of larger scales along the margin. Radial shields broad triangular, with edges rounded, separated widely by a group of disk scales; length to breadth 2·3 : 2. On the under surface the scales are more uniform, and are arranged in irregular transverse rows, four to six in each row. The genital plate, except at its outer end, appears only as a

narrow line, bearing a close row of short, square papillæ, which become larger and more rounded where they form the arm comb. Three short, bluntly-pointed arm spines, situated near the junction of the side with the under arm plate. Seven square, close-set scales on each side of mouth tentacle pores; the next two pairs have four on each side; the next one usually three on the inside and two on the other; beyond the disk only one on the inner side. Colour in alcohol, white.

Station 237.—June 17, 1875; lat. 34° 37′ N., long. 140° 32′ E.; 1875 fathoms; mud.

Ophioglypha undulata, Lym. (Pl. V. figs. 10–12).

Ophioglypha undulata, Lym., Bull. Mus. Comp. Zool., vol. v., part 7, p. 75, pl. iii. figs. 61, 62, 1878.

Three very short, conical arm spines, standing on middle of edge of plate. Disk scales coarse and rather thick. Radial shields broader than long, and joined. Papillæ of arm comb close set, flat, and with rounded ends.

(Type specimen from Station 224.) Diameter of disk 12 mm. Width of arm close to disk, without spines, 2·3 mm. Mouth papillæ four on each side, short and square and closely set, the outer one widest; at angle of the jaw usually a cluster of three conical papillæ. Mouth shield rounded triangular, much broader than long, with an obtuse angle within, and outer side slightly curved; length to breadth 2·3 : 2·3. Side mouth shields nearly straight, rather long, and meeting fully within. First under arm plate oval or rounded hexagonal, and wider than long; the next longer than any other, axe-shaped, with long lateral sides re-enteringly curved and outer side curved; those beyond grow rapidly shorter, and beyond the fourth are separated by the side arm plates, which are regular and scarcely swollen, and meet above and below beyond the fourth upper arm plate. First upper arm plate wide, semicircular; the rest diamond shaped, with inner angle truncated and the outer more or less curved. Disk high, covered with rather thin, irregular, curved plates, among which may be seen a central five-sided primary, and a large wide plate on the margin of the disk, much broader than long. Radial shields rudely semicircular, and meeting only at their outer points, diverging inward, where they are separated by a small triangular plate. The interbrachial space on the under surface is covered by the rather long and narrow genital scales, which are broken in two, and bear no papillæ, and by two large irregularly curved plates, between which and the mouth shield are from one to three little scales. Arm spines three, short, very small, conical, situated half-way on the outer edge of the side arm plate. Tentacle pores, except the first pair, small and narrow. The first bears about three scales on each side; the second, the same; the third, two; and the fourth, one minute scale on the outer and two on the inner side. Colour in alcohol, disk pale grey, arms white.

Station 224.—March 21, 1875; lat. 7° 45′ N., long. 144° 20′ E.; 1850 fathoms; globigerina ooze.

Ophioglypha costata, Lym. (Pl. V. figs 1–3).

Ophioglypha costata, Lym., Bull. Mus. Comp. Zool., vol. v., part 7, p. 76, pl. iv. figs. 92–94, 1878.

Three very short, blunt, peg-like arm spines, evenly spaced. Disk scales few and large. Radial shields long and separated. Papillæ of arm comb close set, flat, and with rounded ends.

(Type specimen from Station 142.) Diameter of disk 6·5 mm. Width of arm close to disk 1·3 mm. Mouth papillæ five or six on each side, short, square, close set, with one larger, diamond-shaped, at apex of jaw. Mouth shield five-sided, with outer edge curved, lateral sides nearly straight, and an obtuse angle within; length to breadth 1 : 1. Side mouth shields rather short, lying along inner angle of mouth shield, and meeting within. First under arm plate broad triangular, with an angle within and curved outer edge; the rest are pentagonal, broader than long, with an obtuse angle within, short lateral sides, and a long curved outer edge. Side arm plates a little swollen and constricted at their inner end, meeting below; separated above for the first three joints by the upper arm plates, of which the first is transverse oval; the second four-sided, with a curved outer edge much wider than the inner; and the rest triangular, with an angle within and curved outer edge. Disk rather flat, and covered by angular plates and a few small rounded scales, closely overlapping; in centre a five-sided rosette of primary plates, which are rounded and partly separated by minute scales; in the interbrachial spaces a single or double row of larger and smaller plates. Radial shields rhomboidal, with the angles slightly rounded; length to breadth 2 : 1; separated without by a large diamond-shaped plate, with its outer and inner angles truncated. The lower interbrachial spaces have a large marginal plate and four or five smaller ones; genital scales wide, bearing on their free edge a close-set row of fine papillæ, which grow somewhat larger and more rounded above to form the arm comb. Three arm spines, minute, blunt, and equally spaced. Tentacle scales short and squarish, five on one side and three on the other of the pores of the mouth tentacles; the second pores have three on each side, and those beyond not so many. Beyond the disk there are no tentacle scales, and the tentacles are very minute. Colour in alcohol, white.

This species is pretty near *Ophioglypha lymani*, but is readily distinguished by its flat upper arm plates, those of *Ophioglypha lymani* being high and more or less ridged.

Station 141.—December 17, 1873; lat. 34° 41′ S., long. 18° 36′ E.; 98 fathoms; (young); sand and gravel. Station 142.—December 18, 1873; lat. 35° 4′ S., long. 18° 37′ E.; 150 fathoms; sand.

Ophioglypha albata, Lym. (Pl. V. figs. 13–15).

Ophioglypha albata, Lym., Bull. Mus. Comp. Zool., vol. v., part 7, p. 77, pl. iv. figs. 95–97, 1878.

Six short, blunt, peg-like, evenly-spaced arm spines. Arms narrow. Radial shields short, and separated by one or two large rounded plates. Disk scales thin, even and hard to distinguish. Papillæ of arm comb close set, flat, and with rounded ends.

(Type specimen from Station 236.) Diameter of disk 10 mm. Length of arm about 40 mm. Width of arm close to disk 2 mm. Three short, crowded mouth papillæ on each side, with one (or sometimes three) conical at apex of jaw. Mouth shield pentagonal, having a blunt angle within and outer corners curved; length to breadth 1·5 : 1·3. Side mouth shields narrow, meeting within; running along inner angle of mouth shield, and passing beyond to join first under arm plate, where they are widest. First under arm plate irregular transverse oval; second plate short, bell-shaped, wider without than within; those immediately beyond are five-sided, wider without than within, with outer edge curved, a blunt angle inward, and inner lateral sides a little re-enteringly curved; about half-way out on the arm they become nearly triangular, broader than long, with outer angles much rounded. Side arm plates broad, but little swollen, not meeting below within the disk, widely separated above by the upper arm plates, of which the second and third are hexagonal, while those beyond are lengthened, their two outer angles blended in a curve and the inner side very short. Disk smooth and slightly arched, covered with thin, rounded or angular, closely-soldered scales, the six primaries being a little larger and separated by one or two rows of scales; there is a transverse row of three large angular plates extending along the margin and connecting the radial shields, which are longer than wide, angular, widely separated by two or three large scales; their outer points may or may not meet: under surface covered by rows of thin, ill-defined plates, similar to those above. Genital scales hidden by the disk scales; along their free edge is a close row of short, bead-like papillæ; they become larger and more rounded where they pass upward to make the arm comb, which is attached to the radial shield. Six short blunt, conical arm spines, arranged along the entire margin of the side arm plate. The pores of the mouth tentacles are large, and have four short close-set scales on either side; the two next have three small rounded scales on the inner side; those beyond have two. There are also minute and not easily seen scales on the outer side of the second and third pores. Colour in alcohol, white.

Station 236.—June 5, 1875; lat. 34° 58′ N., long. 139° 30′ E.; 775 fathoms; mud.

Ophioglypha jejuna, Lym. (Pl. V. figs. 4–6).

Ophioglypha jejuna, Lym., Bull. Mus. Comp. Zool., vol. v., part 7, p. 78, pl. ii. figs. 55, 56, 1878.

Three slender, pointed arm spines, about two-thirds as long as a joint. Disk scales few and mostly large. Radial shields large and jointed. Papillæ of arm comb close set, flat, and with rounded ends.

(Type specimen from Station 135.) Diameter of disk 5 mm. Width of arm 1 mm. Mouth papillæ small, tooth-like, and close set, five on each side, with a long pointed one at apex of jaw; those near the outer angle of the jaw broader than long, growing longer as they near the inner angle. Mouth shield pentagonal, length and breadth about equal, the outer and lateral sides curved, with corners rounded and a very blunt angle inward. Side mouth shields long and narrow, curved, with club-like outer ends; narrower within, where they barely meet. First under arm plate large and triangular, with outer end curved and a blunt angle inward; second and third plate five-sided, with lateral sides nearly straight and outer corners rounded. Side arm plates broad, slightly swollen, meeting below, but separated above on first two joints by upper arm plates, which are wedge-shaped, with outer side curved and a long sharp angle within; those beyond are similar, but separated by side arm plates. Disk flat and smooth, covered with thin rounded plates or scales; in centre of upper surface is a close rosette of five round primary plates, with three small ones in their midst; in each interbrachial space are two large rounded plates, of which the outer is marginal, with some small scales on either side. Radial shields rudely triangular, with an angle inward, joined, except at their inner points, where they are separated by a small wedgescale; length to breadth 1 : ·7. Genital scales long and narrow, wider without than within, bearing on their free edge a row of fine, close-set, tooth-like papillæ, extending to base of upper arm plate, where they become scale-like and form the arm comb. Interbrachial spaces below covered by half a dozen rounded plates or scales of several sizes, whereof the largest lies on the margin. Arm spines three, delicately tapering, about two-thirds as long as a joint, equally spaced on the side arm plate. Scales of mouth tentacles small and tooth-like; four on the brachial side and five on the other; on the next three pores are only two pointed, spine-like scales. Colour in alcohol, brown.

Station 135.—October 16, 17, 18, 1873; off Tristan d'Acunha; 500 and 1000 fathoms; rock, shells. Station 164*a*.—June 13, 1874; lat. 34° 13′ S., long. 151° 38′ E.; 410 fathoms; blue mud.

Ophioglypha brevispina (?), E. A. Smith.

Ophioglypha brevispina, E. A. Smith, Ann. Mag. Nat. Hist., vol. xvii. p. 112, Feb. 1876; Transit of Venus Expedition, p. 11, pl. xvii. figs. 5*a*, *c*.—Lym., Bull. Mus. Comp. Zool., vol. v., part 7, p. 78, pl. ii. figs. 44–46.

Three short, blunt, peg-like arm spines, evenly spaced. Papillæ of arm comb short, close set, and sharp. Disk scales of moderate size, thick and swollen. Very small, narrow side mouth shields.

(Type specimen from Royal Sound, Kerguelen.) Diameter of disk 11 mm. Length of arm 45 mm. Width of arm 2·5 mm. Mouth papillæ short, blunt, close set, four or five on each side, and two longer at apex of jaw. Mouth shield pentagonal, with a blunt angle inward, outer edge curved, lateral sides notched; length to breadth, 2·3 : 2. Side mouth shields extending along inner angle of mouth shield, narrow, of about even width, meeting within. First under arm plate very large, broader than long, transverse oval in shape; next three plates wider without than within, their sides straight, except the outer, which is curved; the rest are triangular, with outer edge curved, and an angle within. Side arm plates short, slightly swollen, just meeting below beyond the disk; widely separated above by the upper arm plates, which are large, arched, much broader than long, wider without than within, with outer side curved and inner side re-enteringly curved. The upper surface of disk has numerous rounded, much swollen plates, closely soldered together, with a cluster of six primaries in the centre separated by one or two rows of smaller plates; outside this cluster in each interbrachial space is another large rounded plate. Radial shields longer than broad, much rounded, their inner ends slightly smaller than the outer, and widely separated by a large rounded triangular plate within and smaller scales without; length to breadth 2:1·5. Interbrachial space below evenly covered by small thick scales. The genital scale is nearly or quite covered, except at its outer portion, whose free edge carries a row of very fine saw-like papillæ, which become a little longer above, where they make the arm comb. Three small blunt arm spines, equally spaced, and standing low on the outer edge of side arm plate. The pores of the mouth tentacles have four or five close-set, small, tooth-like scales on each side; the second and third set have four or five on the interbrachial side, and three on the brachial; beyond this they diminish till a short distance beyond the disk, where there is on the inner side a small scale, similar to and continuous with the arm spines, and on the outer side a little ridge. Colour in alcohol, light grey.

Mr. Smith, who kindly compared a Challenger specimen with his originals, reports that the latter are smaller, and differ from the former in having disk scales coarser, radial shields that converge and touch each other, upper arm plates narrower inward, &c. As these differences may depend on age, I have retained the name with a query.

Royal Sound, Kerguelen Islands; 25 to 28 fathoms. Balfour Bay, Kerguelen Islands; 20 to 60 fathoms. Off Christmas Harbour, Kerguelen Islands; 120 fathoms.

Ophioglypha ambigua, Lym. (Pl. VIII. figs. 4, 5).

Ophioglypha ambigua, Lym., Bull. Mus. Comp. Zool., vol. v., pt. 7, p. 79, pl. ii. figs. 47, 48, 1878.

Four short, blunt, peg-like arm spines, three together, low down, and one higher up. Papillæ of arm comb short, close set, and squarish. Disk scales of moderate size, thick and swollen. Very small, narrow side mouth shields.

(Type specimen from Royal Sound, Kerguelen.) Diameter of disk, 13·5 mm. Width of the arm close to disk 2·5 mm. Mouth papillæ short, blunt, tooth-like, and close set, five on each side, similar to and continuous with the tentacle scales of the mouth tentacles, with a larger, longer, and pointed one at angle of jaw. Mouth shield pentagonal, with outer edge rounded, lateral sides notched, and a blunt angle inward; length to breadth 3 : 2. Side mouth shields short, just meeting within and slightly wider at their outer end. First under arm plate large, rudely diamond-shaped, with outer and inner angles rounded; the next two or three plates four sided, wider without than within, with outer side curved and re-entering curves on lateral sides; further out they become pentagonal, much broader than long, with an angle inward. Side arm plates short and thick, not meeting below till some distance from the disk; widely separated above by upper arm plates, much broader than long, arched, wider without than within, outer edge curved, inner edge re-enteringly curved. Disk thick and angular, covered with thick, closely soldered, irregularly shaped plates, among which the primaries may be distinguished, but not very clearly. Radial shields small, irregularly triangular, with angles rounded, widely separated by one large and two or three small scales; length to breadth 2 : 1·5. Genital plates short, beginning opposite fourth under arm plate and widening rapidly outward; along the free edge is a row of fine, short, square, close-set papillæ, extending as an unbroken line upward to form the arm comb. Four short, blunt, and tooth-like arm spines, three in a cluster, close to edge of tentacle pores, and one a little separated above; farther out the four make a continuous group. Tentacle pores large; those of the mouth tentacles have five short, rounded scales on the interbrachial side and four on the other; the next pair, six on one side and five on the other; thence they diminish till some distance beyond the disk, where there is but one tentacle scale, similar to and continuous with the arm spines. Colour in alcohol, light grey.

It is near *Ophioglypha brevispina*, from which it differs in having one more arm spine, and an arm comb of close-set, square papillæ, instead of pointed ones.

Royal Sound, Kerguelen Islands; 25 to 28 fathoms. Off Christmas Harbour, Kerguelen Islands; 120 fathoms.

Ophioglypha loveni, Lym. (Pl. VIII. figs. 1–3).

Ophioglypha loveni, Lym., Bull. Mus. Comp. Zool., vol. v., part 7, p. 80, pl. iv. figs. 109–111, 1878.

Three to five short, sharp arm spines, about half as long as a joint. Disk smooth and flat, with scales, radial shields, and mouth shields all small.

(Type specimen from Station 157.) Diameter of disk 21 mm. Width of arm close to disk 3·7 mm. Six or seven small rounded mouth papillæ on each side, the outer three being closely soldered together; at apex of jaw a clump of three larger papillæ. Mouth shields triangular, with an obtuse angle within, and the outer edge much rounded; length to breadth 3·5 : 4. Side mouth shields following inner angle of the mouth shield, rather narrow without, where the mouth tentacle pores encroach, wider within, where they scarcely meet. First under arm plate broad triangular, or broad rounded hexagonal, with outer edge much curved, and a very blunt angle inward; second plate nearly square, with rounded corners; the next two rudely semicircular, with outer edge straight, or broad much rounded pentagonal, with an ill-marked angle inward; the rest are transverse oval, with a peak inward. Side arm plates wide, a little swollen, meeting below beyond the disk, separated above by the upper arm plates, which are much broader than long, with outer edge broken in three angles or curved, and the lateral sides forming an angle. Disk arched, but not thick, covered above and below with small, thin, closely soldered scales, the six primaries being small, circular, widely separated plates. Radial shields much longer than wide, with a sharp angle inward, separated by a wedge of disk scales; length to breadth 4·5 : 2. Genital scales very narrow, covered by fine scaling, bearing on their free edge a close row of very fine, square papillæ, which increase a little in size as they appear above to form the arm comb. Three tapering arm spines, about half as long as a joint; the upper one the longest. Larger specimens have five or more spines. On the mouth tentacle pores there are seven or eight close-set, tooth-like scales on either side; the next two pairs have six or seven on each side; just beyond the disk there are four scales on the inner side, and the same number of smaller ones on the outer. Colour in alcohol, grey.

Station 146.—December 29, 1873; lat. 46° 46′ S., long. 45° 31′ E.; 1375 fathoms; globigerina ooze. Station 147.—December 30, 1873; lat. 46° 16′ S., long. 48° 27′ E.; 1600 fathoms; globigerina ooze. Station 157.—March 3, 1874; lat. 53° 55′ S., long. 108° 35′ E.; 1950 fathoms; diatom ooze. Station 158.—March 7, 1874; lat. 50° 1′ S., long. 123° 4′ E. (same species?); 1800 fathoms; globigerina ooze. Station 160.—March 13, 1874; lat. 42° 42′ S., long. 134° 10′ E.; 2600 fathoms; red clay.

Ophioglypha fraterna, Lym. (Pl. VIII. fig. 6).

Ophioglypha fraterna, Lym., Bull. Mus. Comp. Zool., vol. v., part 7, p. 81, pl. iv. fig. 112, 1878.

Five very minute, blunt arm spines, which often are rubbed off or naturally wanting. Disk smooth and flat, with scales, radial shields, and mouth shields all small, and obscured by skin. No arm comb.

(Type specimen from Station 157.) Diameter of disk 23·5 mm. Width of arm close to disk 3·7 mm. Mouth papillæ short, squarish, closely jointed together, seven or eight on each side, diminishing in size inward, with three pointed and longer at apex of jaw. Mouth shield small, broader than long, pentagonal, with outer edge rounded and an obtuse angle within; length to breadth 3 : 3. Side mouth shields occupying the inner angle of the mouth shield, and passing beyond it; narrower without than within, where they meet. First under arm plate much broader than long, with outer edge curved; second plate six-sided, with inner laterals longest; beyond the disk they are very broad triangular, with long sharp lateral angles, an obtuse angle inward, and the outer side curved. Often the lateral corners are broken off, and form separate pieces. Side arm plates broad, not swollen, meeting below beyond the disk; separated above by the upper arm plates, which are broader than long, and broader without than within, having the outer edge wavy. Disk high and irregularly arched, covered above and below with a thick skin, which almost entirely obscures the fine disk scales and the radial shields, which may be recognised as small, oval, smooth patches near the disk margin, on either side of the arm. Along the edge of the genital opening is a row of minute, closely-joined, squarish papillæ, which extend only to the margin of the disk, the arm comb being absent. Five very minute, blunt arm spines, three situated low on the edge of side arm plate and two above. Often they are rubbed off, and there seem to be none. Tentacle scales of the mouth tentacles similar to mouth papillæ and on one side, closely continuous with them; on the first pair there are four or five scales on each side; on the second five or six on each side; just outside the disk there are four scales on the inner side, and none on the other; and a short distance beyond there are no scales. Colour in alcohol, light grey.

It differs from *Ophioglypha loveni* in wanting an arm comb, and in having the disk scales and radial shields obscured by skin.

Station 157.—March 3, 1874; lat. 53° 55′ S., long. 108° 35′ E.; 1950 fathoms; diatom ooze.

Ophioglypha elevata, Lym. (Pl. V. figs. 16–18).

Ophioglypha elevata, Lym., Bull. Mus. Comp. Zool., vol. v., part 7, p. 82, pl. iv. figs. 87–89, 1878.

Disk high and arched. Arms short and thick. Each under arm plate has a median, elongated, bead-like swelling.

(Type specimen from Station 145.) Diameter of disk 6 mm. Length of arm about 11 mm. Width of arm close to disk, without spines, 1·3 mm. Five short, square, closely-jointed mouth papillæ on each side, and one longer diamond-shaped at apex of jaw. Mouth shield longer than wide, broader without than within, deeply constricted at the sides, and curved at both ends; length to breadth 1 : ·7. Side mouth shields narrow, of even width, curving round the inner lobe of the mouth shield and meeting within. First under arm plate triangular, with angle inward and outer side curved; second, third, and fourth plates four sided, with outer edge, which is wider than inner, curved, and lateral sides re-enteringly curved. There is a longitudinal swelling on the under arm plates which forms a continuous ridge within the disk. Side arm plates wide, little swollen, constricted within, not meeting below on basal joints; separated above by the upper arm plates, which are four sided, much broader than long, wider without than within, with outer and inner edges straight, and lateral sides re-enteringly curved. Disk thick and arched, covered with small, swollen, irregular scales, with one large pentagonal primary plate in centre. Radial shields small, as wide as long, irregularly triangular, joined their entire length; length to breadth ·7 : ·7. Lower interbrachial space filled with small rounded scales; along the free edge of the genital scale is a row of very minute pointed papillæ, which suddenly become long and spine-like as they pass upward to make the arm comb. Five short blunt arm spines, three well up on the edge of the side arm plate, and two somewhat shorter close to tentacle pores. On the mouth tentacle pores there are two large scales on either side; the other pores within the disk have three long rounded scales on the inner side, and one very wide, thick, erect scale on the outer side, the latter being sometimes in two pieces; beyond the disk there is on each pore a larger and a smaller short curved scale. Colour in alcohol, light brown.

Station 145.—December 27, 1873; lat. 46° 40′ S., long. 37° 50′ E.; 310 fathoms.

Ophioglypha bullata, Wyv. Thom. (Pl. XXXVIII. figs. 14–17).

Ophioglypha bullata, Wyv. Thom., Nature, vol. viii. p. 400 (figured), 1873; Voy. "Chall." Atlantic, vol. i. p. 400 (figured). Lym., Bull. Mus. Comp. Zool., vol. v., part 7, p. 83, pl. iii. figs. 85, 86.

Three minute, evenly spaced arm spines. Disk scales above rounded, and of various sizes, with large marginal plates. Disk high. Basal under arm plates about as long as broad. Arms high and rounded.

(Type specimen from Station 61.) Diameter of disk 11 mm. Length of arm 23 mm.

Width of arm close to disk 2 mm. Four or five small, conical, widely separated mouth papillæ on each side, and three larger at apex of jaw. Mouth shield very large, long pentagonal, with an obtuse angle inward much wider without than within; outer lateral corners rounded; length to breadth 2·7 : 2·3. Side mouth shields pointed oval, small, meeting widely within. First under arm plate triangular, with sharp angle inward and outer edge curved; the rest within the disk four sided, with inner edge slightly wider than outer, and lateral side a little re-enteringly curved; beyond they gradually become wide hexagonal. Side arm plates swollen, not meeting below till half a dozen joints beyond the disk; separated above by upper arm plates, which are much swollen, forming a high ridge; the first two or three nearly square with rounded corners; those just beyond rounded hexagonal; and only near the middle of the arm do they become triangular, with an angle within and outer edge curved. Disk thick and arched; in centre of upper surface a cluster of six large, round primary plates, separated by an irregular row of smaller; between inner ends of radial shields and in each interbrachial space a conspicuous round plate; on the margin are two plates connecting outer ends of genital scales, and within these a large plate connecting outer ends of radial shields; rest of upper surface covered with small, swollen, rounded scales. Radial shields longer than broad, rounded pear-seed shape, forming a well-marked notch over arm; separated their entire length by a single or double row of rounded scales; length to breadth 2.7 : 2. The under interbrachial space is occupied by the large mouth shield, the lower edges of the two small marginal plates, and the large genital scales, which are very narrow within, widening without, as they extend upward over the arm, and bearing on their free edge a close row of square, flat papillæ, which begin at the third arm plate and maintain the same shape in the arm comb. Three minute pointed arm spines, evenly spaced; the lowest next the tentacle scales. Tentacle pores oval and very large; four short rounded scales on each side of mouth tentacles; the rest, within and well beyond the disk, have four or more on the inner side, and one or two on the outer side. The entire surface is microscopically tuberculous. Colour in alcohol, straw.

Station 45.—May 3, 1873; lat. 38° 34′ N., long. 72° 10′ W.; 1240 fathoms; (young); mud. Station 54.—May 27, 1873; lat. 34° 51′ N., long. 63° 59′ W.; 2650 fathoms; grey ooze. Station 61.—June 17, 1873; lat. 34° 54′ N., long. 56° 38′ W.; 2850 fathoms; grey ooze. Station 133.—October 11, 1873; lat. 35° 41′ S., long. 20° 55′ W.; 1900 fathoms; globigerina ooze.

Ophioglypha convexa, Lym. (Pl. VI. figs. 13–15).

Ophioglypha convexa, Lym., Bull. Mus. Comp. Zool., vol. v., part 7, p. 84, pl. iii. figs. 83, 84, 1878.

Three small tapering arm spines. Disk covered above by a rosette of large, angular, primary plates, radial shields, and a few large interbrachial plates.

(Type specimen from Station 241.) Diameter of disk 12 mm. Length of arm 30 mm. Width of arm close to disk, without spines, 3 mm. Mouth papillæ small, conical, four to six on each side, and three larger at angle of jaw. Mouth shield large, much longer than wide, five-sided, with an angle inward, and outer edge, which is wider than inner, much curved; length to breadth 4 : 3·5. Side mouth shields short, wider within than without, meeting broadly and occupying only the inner angle of the mouth shield. First under arm plate three-sided, with truncated angles; beyond they are nearly square, with truncated corners and their lateral sides re-enteringly curved; those farther out are octagonal, and afterwards hexagonal. Side arm plates thick, swollen, meeting neither above nor below, except at end of arm. Upper arm plates much broader than long, hexagonal, arched. Disk thick, covered above by a few stout plates. Radial shields angular, pear-seed shape, somewhat sunken, joined without but diverging inward, where they are separated by a thick wedge-like scale; length to breadth 3 : 2. In the interbrachial spaces are five large plates, two on margin of disk, connecting the outer ends of the genital scales; one quadrangular, connecting the radial shields; and two smaller, which lie between inner ends of radial shields. The central space is covered by six regular, stout primary plates, elevated above the rest, the central one pentagonal, the others hexagonal. The genital scales fill the lower interbrachial space between mouth shield and arm, and bear on their free edge a close row of square papillæ, which become peg-like on the arm comb. Beyond the mouth shield is a row of three small rounded marginal plates. Three short, delicate, tapering arm spines, equally spaced. Tentacle pores within the disk have two or three scales on the inner side, and one or more on the outer. Colour in alcohol, yellowish-grey.

Station 241.—June 23, 1875; lat. 35° 41′ N., long. 157° 42′ E.; 2300 fathoms; (young); red clay. Station 246.—July 2, 1875; lat. 36° 10′ N., long. 178° 0′ E.; 2050 fathoms; grey ooze. Station 346.—April 6, 1876; lat. 2° 42′ S., long. 14° 41′ W.; 2350 fathoms; globigerina ooze.

Ophioglypha sculptilis, Lym. (Pl. VI. figs. 16–18).

Ophioglypha sculptilis, Lym., Bull. Mus. Comp. Zool., vol. v., part 7, p. 84, pl. iv. figs. 115, 116, 1878.

Six minute arm spines. First under arm plate broader than long; those beyond longer than broad. Radial shields separated within by a cluster of large scales. Disk high. Basal under arm plates about as long as broad. Arms high and rounded.

(Type specimen from Station 237.) Diameter of disk 12·5 mm. Width of arm close to disk 3 mm. Mouth papillæ five on each side, broader than long, shaped like blunt saw-teeth, with two blunt pointed papillæ at apex of jaw. Mouth shield much rounded, pentagonal, with an angle inward, and two outer angles almost blended in a wide curve; length to

breadth 3·5 : 2·5. Side mouth shields narrow, curved, pointed within, where they broadly meet. The first under arm plate broad triangular, with outer edge curved, and a blunt angle within; the next three long axe shape, with outer edge, which is wider than inner, slightly curved, and lateral sides re-enteringly curved; beyond the disk they are similar, but present an angle inward. Side arm plates minutely tuberculous, broad, and swollen meeting below at some distance beyond the disk; separated above by upper arm plates, of which the first is much wider than long; the second wide semicircular, with outer edge curved; the third narrower, with outer edge curved, and wider than the inner; the rest rounded diamond shape, with the inner angle longer than the outer. Disk thick, covered with thin flat plates; in the centre is a large round primary plate, surrounded by five smaller, separated by two or three rows of fine scales; in the interbrachial spaces are three large plates in a line, of which the outer is marginal and has usually a round plate on either side. Radial shields irregular blunt pear-seed shape, touching without, diverging inward, where they are separated by a wedge of three or four small rounded scales. Genital scales narrow within, growing much wider without; bearing on their free edge a close row of squarish papillæ, which become spiniform where they pass upward to form the arm comb. Six minute blunt arm spines equally spaced along the side arm plate. Four or five small blunt tentacle scales on each side of pores within the disk; beyond the disk they soon diminish to two standing inside of pore. Colour in alcohol, light grey.

Station 237.—June 17, 1875; lat. 34° 37′ N., long. 140° 32′ E.; 1875 fathoms; mud.

Ophioglypha variabilis, Lym. (Pl. VI. figs. 10–12).

Ophioglypha variabilis, Lym., Bull. Mus. Comp. Zool., vol. v., part 7, p. 85, pl. iii. figs. 70, 78, 79, 1878; Bull. Mus. Comp. Zool., vol. v., part 9, p. 217.

Four or five minute arm spines. Under arm plates longer than broad. Radial shields separated at inner ends by a single scale. Disk high. Basal under arm plates about as long as broad. Arms high and rounded.

(Type specimen from Station 195.) Diameter of disk 11·5 mm. Length of arm about 40 mm. Width of arm close to disk 2·7 mm. Mouth papillæ six on each side, of which three are square and three pointed, and one larger and diamond shaped at apex of jaw; they are all low and somewhat irregular. Mouth shield blunt pear-seed shape with an angle within, or of a much rounded pentagonal form with an angle within and a curve without; length to breadth 3·3 : 2·7. Side mouth shields narrow, meeting within and there forming a sharp angle. First under arm plate triangular, outer edge curved, inner angle blunt; the next three plates are long axe-shaped, with outer edge, which is wider than inner, curved, and re-entering curves on the lateral sides; those beyond are separated

by side arm plates, and are pentagonal, with an angle inward, and outer side curved. Side arm plates broad, somewhat swollen, meeting below beyond the fourth under arm plate, and above beyond the fourth upper arm plate, where they form almost the entire covering of the arm; their surface presents a minute crystalline appearance. Upper arm plates triangular, with an angle inward and a curve without; the first three are broader and have the inner angle truncated. Disk thick, rather flat, covered above with thin, closely overlapping scales; a cluster in the centre of one large rounded primary plate and one smaller to each brachial space, separated by two or three rows of much smaller scales; in the interbrachial spaces are three large plates,—an oval marginal, connecting the outer ends of the genital scales; a second inside, joining the radial shields by a line of small scales; and a third, smaller and more rounded, which lies between the inner ends of the radial shields. These last are three sided, with corners much rounded and a blunt angle inward, touching without, diverging inward, where they are separated by a small rounded scale; length to breadth 2·5 : 2. The under surface is occupied by the large mouth shield; three to five small plates, just outside, and the broad genital scales, which, starting very narrow from the lateral side of the mouth shield, increase in width as they curve upward over the arm; along their free edge, on the under surface, is a close row of large square papillæ, which become spiniform on the arm comb. Four or five minute, round, pointed arm spines, evenly spaced along edge of side arm plate. Tentacle pores very large, the basal ones oval, the rest round; those of the mouth tentacles have three or four scales on each side; the next two sets, three on either side, those next the arm plate being larger than the others; just beyond the disk they have two small scales on the inner edge, and one larger one next the arm plate, and further out there are no scales. Colour in alcohol, grey.

One specimen had a double vertical row of large scales on the interbrachial edge, instead of a single large plate.

Station 195.—October 3, 1874; lat. 4° 21′ S., long. 129° 7′ E.; 1425 fathoms; grey ooze. Station 24.—March 25, 1873; off Culebra Island; (same species?); 390 fathoms; (young); mud.

Ophioglypha ornata, Lym. (Pl. VI. figs. 1–3).

Ophioglypha ornata, Lym., Bull. Mus. Comp. Zool., vol. v., part 7, p. 86, pl. iv. figs. 113, 114, 1878.

Three or four minute, widely spaced arm spines. Mouth shield trefoil, with a pointed lobe inward. Disk high. Basal under arm plates about as long as broad. Arms high and rounded.

(Type specimen from Station 216.) Diameter of disk 10 mm. Width of arm close to disk 3 mm. Five or six short, square, close-set mouth papillæ on each side, the outer ones

wider than the inner, with two pointed ones at apex of jaw. Mouth shield large, much rounded triangular, with a lateral constriction which makes a pointed lobe inward; length to breadth 2·7 : 2·5. Side mouth shields long, crooked, and very narrow, meeting within. First and second under arm plates larger than those beyond, axe-shaped, with outer edge wide and curved, and lateral sides re-enteringly curved; those beyond are similar, but present an angle inward. Side arm plates swollen, broad, minutely tuberculated, meeting below, outside the disk; separated above by upper arm plates, which are narrow, four sided, much swollen, with curved lateral and straight outer and inner sides; towards the middle of the arm they become longitudinal oval. Disk thick, smooth, and angular, covered in the centre by small, thin, irregular overlapping scales, in the midst of which are the six primary plates, which are rounded and rather small. In each interbrachial space, and connecting the radial shields, is a large rounded angular plate. Outside of this are two large marginal plates, which extend below nearly or quite to the outer edge of the mouth shield. Radial shields much rounded triangular, broadly meeting without, separated within by two or three disk scales; length to breadth 2 : 1·7. Interbrachial spaces below covered by the two great marginal plates, between which and the mouth shield there are sometimes two or three small scales. Genital scales rather wide, and carrying on the free edge a row of large, square, close-set papillæ, which become spiniform where they form the arm comb. Usually three, rarely four, very minute arm spines, one at the top, one near the middle, and one at the lower edge of the side arm plate. Mouth tentacle pores separated from mouth slit. Three or four small rounded tentacle scales on each side of first three sets of tentacle pores; those just beyond the disk have two or three scales on the inner, and two on the outer side. Colour in alcohol, light grey.

Station 216.—February 16, 1875; lat. 2° 56′ N., long. 134° 11′ E.; 2000 fathoms; globigerina ooze.

Ophioglypha lacazei, Lym. (Pl. VI. figs. 4–6).

Ophioglypha lacazei, Lym., Bull. Mus. Comp. Zool., vol. v., part 7, p. 87, pl. iii. figs. 58–60, 1878.

Three minute arm spines, high up. Radial shields rounded, separated by one scale within. One large marginal plate, with small scales about it. Disk plates closely soldered and ill defined. Disk high. Basal under arm plates about as long as broad. Arms high and rounded.

(Type specimen from Station 160.) Diameter of disk 11 mm. Length of arm about 30 mm. Width of arm close to disk 2·3 mm. Mouth papillæ very small and widely separated; eleven to thirteen to each angle; one large at apex of jaw. Mouth shield large, much rounded pentagonal, with obtuse angle inward, and outer side curved; length to breadth

2·5 : 2·5. Side mouth shields rather short and wide, meeting within, where they are broader than without. First under arm plate long, wedge-shape, with outer edge curved; the rest axe-shaped, with outer edge curved, and lateral sides re-enteringly curved. Side arm plates regular and scarcely swollen. Upper arm plates large, broader than long, hexagonal, with outer angles much rounded; length to breadth 1 : 1·3. Farther out they become nearly semi-circular, with the curve inward. Disk covered with rounded, flat, thin, closely-joined plates, among which may be seen a central rosette of primaries, and two larger plates in each interbrachial space. Radial shields short, wide, rudely semi-circular, touching along part of their length, separated within by small wedge-like scales. The interbrachial space on the under surface is nearly covered by the large mouth shield. The genital scales are broad and slightly curved, and bear rather stout tooth-like papillæ. Outside the mouth shield are two rows of small thin semicircular scales. The papillæ of the arm comb are flat, squarish, and separated, and are borne by a semicircular plate about as broad as long. Three minute arm spines, pointed and standing well up on the outer edge of the side arm plate. Tentacle scales of the innermost pair of pores small, semicircular, usually two on either side. The rest of the tentacle pores have usually one large on the outer side, and three or four smaller on the inner side. Colour in alcohol, nearly white.

Station 160.—March 13, 1874; lat. 42° 42′ S., long. 134° 10′ E.; 2600 fathoms; red clay. Station 299.—December 14, 1875; lat. 33° 31′ S., long. 74° 43′ W.; 2160 fathoms; grey mud.

Ophioglypha lienosa, Lym. (Pl. VI. figs. 7–9).

Ophioglypha lienosa, Lym., Bull. Mus. Comp. Zool., vol. v., part 7, p. 88, pl. iii. figs. 80–82, 1878.

Three minute arm spines. Disk covered by small, irregular, ill defined, scales, small separated radial shields, and very large mouth shields. Disk high and flat. Basal under arm plates about as long as broad. Arms high and rounded.

(Type specimen from Station 157.) Diameter of disk 15 mm. Length of arm about 37 mm. Width of arm, without spines, close to disk 3·5 mm. Mouth papillæ small, conical, widely spaced, diminishing in size from within outward; about five on each side and a group of three larger ones at apex of jaw. Mouth shields very long, pentagonal, with an obtuse angle inward, lateral sides re-enteringly curved, and outer edge rounded; length to breadth 3·5 : 3. Side mouth shields short, meeting broadly within, where they are wider than without; occupying only the inner end of the mouth shields. First under arm plate triangular, with an angle inward, and outer edge curved; beyond, the plates are four-sided, thick, with outer and inner edges nearly straight, and lateral sides re-enteringly curved; beyond the disk they become hexagonal; their surface has a minutely crystalline

appearance. Side arm plates swollen, and not meeting below for some distance beyond disk. Upper arm plates broader than long, thick and swollen, with outer side curved and longer than the inner, which is nearly straight; lateral sides re-enteringly curved. Beyond, they are bounded by a long curve within and a peak without. Disk smooth, arched, and very thick, covered above with small thin plates, having a minutely tuberculous or crystalline appearance; in the centre are six circular primary plates, separated by others irregularly shaped and angular, which also fill the interbrachial spaces. Radial shields small, short, and thick, rounded triangular, with an angle outward, separated their entire length by a round plate without and several smaller plates within. Interbrachial space below chiefly covered by the great mouth shields, outside which are three or four rows of small scales, and on either side a genital scale, bearing on the free edge broad, square, close-set papillæ, which become narrower where they form the arm comb, on the broadened outer end of the genital scale. Three small sharp arm spines, one situated in a notch well up on the outer edge of the side arm plate, the other two lower, near junction of side with under arm plate. Tentacle pores very large, transverse oval in shape; on those of the mouth tentacles four rounded scales on the under arm plate, and three on the other side; the other pores within disk have usually four on the inner side, and one wide scale on the outer. Colour in alcohol, body grey, arms straw-colour.

Station 157.—March 3, 1874; lat. 53° 55′ S., long. 108° 35′ E.; 1950 fathoms; diatom ooze.

Ophioglypha radiata, Lym. (Pl. VII. figs. 1–3).

Ophioglypha radiata, Lym., Bull. Mus. Comp. Zool., vol. v., part 7, p. 89, pl. iii. figs. 65, 66, 1878.

Two minute arm spines. Mouth shield trefoil. Under arm plates axe shape. Radial shields small and rounded. Disk high. Basal under arm plates about as long as broad. Arms high and rounded.

(Type specimen from Station 205.) Diameter of disk 8·5 mm. Length of arm 35·5 mm. Width of arm close to disk 3 mm. Four or five wide, rectangular, closely-set mouth papillæ on either side, with three long and pointed at apex of jaw. Mouth shields large, trefoil shape, with a pointed lobe inward. Side mouth shields very narrow, of even width and meeting within. First under arm plate largest of all, triangular, with an angle within and outer edge much curved; the other plates are axe-shaped, with re-entering lateral sides and curved outer side; the first three touch each other. Side arm plates thick, swollen, and minutely tuberculous, meeting on the under surface beyond the third plate. Upper arm plates much swollen, the first two rounded hexagonal, those beyond rounded triangular. Disk high and rounded, covered with fine overlapping scales, of which the marginal are the largest. Radial shields small, broader than long, four-sided, with rounded

corners, outer edges straight, touching nearly their whole length, diverging inward, where they are separated by a small triangular plate. There are small round primary plates, widely separated by the finer disk scales. Genital scales short, wider without than within, bearing along their entire margin long, flat, and closely-set papillæ, about fourteen in number; those towards upper surface much narrower than the under ones. Two very minute arm spines, one situated low on the edge of the side arm plate, next the tentacle pore, the other half-way up the arm. Tentacle scales curved; from three to four on either side of the large pores on the basal joints. Colour in alcohol, pale yellow.

Station 205.—November 13, 1874; lat. 16° 42′ N., long. 119° 22′ E.; 1050 fathoms; grey ooze.

Ophioglypha undata, Lym. (Pl. III. figs 16–18).

Ophioglypha undata, Lym., Bull. Mus. Comp. Zool., vol. v., part 7, p. 90, pl. iv. figs. 101, 102, 1878.

Four minute blunt arm spines. Disk plates rough and lumpy, with rosette of large primaries. Under arm plates pentagonal. Disk high. Basal under arm plates about as long as broad. Arms high and rounded.

(Type specimen from Station 176.) Diameter of disk 3·5 mm. Width of arm close to disk 1 mm. Five mouth papillæ on either side, of which the three outer ones are squarish, and the two innermost pointed and similar to the large one at apex of jaw. Mouth shields five-sided, with outer lateral corners curved and a blunt angle within; length to breadth ·7 : ·5. Side mouth shields rather large, longer than wide; wider without than within, where they meet. First under arm plate long, three-sided, with angles much rounded and lateral sides re-enteringly curved; second and third five-sided, with outer corners rounded, an angle inward, and lateral sides re-enteringly curved; those beyond grow rapidly smaller, but have the same general form. Side arm plates much swollen, but constricted at their inner margin, meeting widely above and below beyond the disk. The first upper arm plate is triangular, with outer edge curved; the second diamond shaped, having the inner angle slightly truncated; beyond this they become rapidly smaller and are diamond shaped. Disk plates above thick, and overlapping like tiles; in the centre is a rosette of the six primary plates, the middle one being pentagonal, and those surrounding it transverse oval; on the outer edge of each of these latter plates are one large and two smaller semicircular plates; in the interbrachial spaces are two large rounded plates, the outer one extending quite to the margin of the disk. Radial shields about as broad as long, angular, closely soldered together. On the under surface the plates are rounded, and so much swollen as to form knobs with furrows between, the

three along the margin being larger than the others. Genital scales narrow, with a row of seven or eight pointed papillæ on the free edge, while the papillæ of the arm comb are longer and more slender. Four minute blunt arm spines on the basal joints. The pores of the mouth tentacles do not open into the mouth-slit: they have three rounded scales on either side; the next two have two scales on either side, and, beyond, two on the inner and one on the outer side. Colour in alcohol, grey.

Station 176.—August 15, 1874; lat. 18° 30′ S., long. 173° 52′ E.; 1450 fathoms; red clay.

Ophioglypha lapidaria, Lym. (Pl. VII. figs. 16–18).

Ophioglypha lapidaria, Lym., Bull. Mus. Comp. Zool., vol. v., part 7, p. 90, pl. iii. figs. 67–69, 1878.

Eleven short, pointed, close-set arm spines. Mouth shields trefoil. Under arm plates squarish. About eight tentacle scales to each pore within the disk. Disk high. Basal under arm plates about as long as broad.

(Type specimen from Station 235.) Diameter of disk 11 mm. Width of arm close to disk 2·5 mm. Five or six short square mouth papillæ on each side, and a cluster of two or three larger at apex of jaw. Mouth shields longer than broad; wider without than within, where they present a rounded angle; outer corners also rounded; on the later sides a constriction which gives them a three-lobed aspect; length to breadth 2·5 : 2·3. Side mouth shields small, long, very narrow; outer end slightly broader than the inner, where they meet. First under arm plate triangular, with truncated angle inward and outer edge curved; the next four are four-sided, with curved outer edge; beyond the disk they are pentagonal, with an obtuse angle inward, short lateral sides, and a long curved outer side. Side arm plates thick, deeply constricted at their inner end; not meeting below till some distance beyond the disk, separated above by upper arm plates, which are broader than long, wider without than within, the outer edge being curved. Disk thick, covered with large, closely-soldered plates and scales. Radial shields pear-seed shape, longer than wide, with an angle within and outer edges rounded; touching without, separated within by a single wedge-like plate; in the centre above is a close rosette, consisting of a pentagonal primary plate, surrounded by five others, smaller and of an irregular shape; the remaining interbrachial space on the upper surface is occupied by rows of semicircular plates. Lower interbrachial space, covered by small curved, overlapping plates. Genital scales very narrow, except without, where they broaden into a wide radial scale, bearing a comb of short spines, which continue below as minute papillæ on the margin of the genital opening. Ten or twelve fine, short, blunt arm

spines, extending in a close continuous row along outer edge of side arm plate. Tentacle scales short, square, large, and thin. The pores of the mouth tentacles carry five or six on each side; the pores immediately beyond are very large, and have about four on each side; beyond the disk they have three or four on the inner side, and one spiniform on the under arm plate. Colour in alcohol, light grey.

Station 235.—June 4, 1875; lat. 34° 7′ N., long. 138° 0′ E.; 565 fathoms; mud.

Ophioglypha solida, Lym. (Pl. III. figs. 7–9).

Ophioglypha solida, Lym., Bull. Mus. Comp. Zool., vol. v., part 7, p. 91, pl. v. figs. 120–122, 1878.

Basal under arm plates, beyond the second, about as long as broad, squarish, and with water pores between them. Arms high, with swollen upper arm plates and very small spines. Upper disk covered in great part by rosette of primary plates and by radial shields.

(Type specimen from Station 192.) Diameter of disk 10·5 mm. Width of arm close to disk, without spines, 3 mm. Eight minute, widely separated, pointed mouth papillæ on each side of angle, with a cluster of three bluntly pointed at apex of jaw. Mouth shields narrow, pear-seed shaped, with sharp angle inward, and outer edge much rounded; length to breadth 2 : 1·5. Side mouth shields longer than broad, much wider without than within, where they meet, extending nearly two-thirds of the distance on sides of mouth shield. First under arm plate three-sided, longer than wide, with rounded angle inward, and a slight re-entering curve on all three sides; the next six or seven plates are broader than long, octagonal, and separated by wide pores or depressions; the remainder of the under arm plates are quadrangular, with an angle within and without. Side arm plates broad and somewhat swollen, meeting below only towards the tip of the arm; separated above by the upper arm plates, which are broader than long, and four sided, with lateral sides straight, and outer edge much wider than inner, and curved; towards the tip of the arm they are diamond shape, with truncated angles without and within. Disk round and high, covered with large, much swollen plates, the central primary being pentagonal, surrounded by five others, large and more or less rounded; in the upper interbrachial space are two plates, the inner one rounded, the outer marginal one much broader than long, and somewhat swollen. Radial shields joined, small, and irregular in shape, curved without. Lower interbrachial space covered by two much swollen plates, longer than wide, extending from the outer edge of the mouth shield to the marginal plate. Genital scales much longer than wide, wider without, tapering inward, carrying along their free edge, from the outer edge of the mouth shield to the edge of the disk,

a row of minute papillæ, which become somewhat longer as they appear above the arm to form the comb. Two, and sometimes three, small, delicately tapering arm spines, about half as long as a joint. Tentacle scales on first pair of pores, three on either side; on the second, three or four on the interbrachial side, and two on the brachial; third pair the same, but only one on the brachial; beyond there are three long blunt scales on the interbrachial side. Colour in alcohol, white.

Although from only 129 fathoms, this species has the look of a deep-sea inhabitant.

Station 192.—September 26, 1874; lat. 5° 42′ S., long. 132° 25′ E.; 129 fathoms; mud.

Ophioglypha rugosa, Lym. (Pl. III. figs. 13–15).

Ophioglypha rugosa, Lym., Bull. Mus. Comp. Zool., vol. v., part 7, p. 92, pl. iv. figs. 90, 91, 1878.

Disk covered with much swollen, lumpy plates. Genital scales wide, thick, and in a single piece. Basal under arm plates longer than wide. Papillæ of arm comb short, flat, close set, and with rounded ends.

(Type specimen from Station 169.) Diameter of disk 7 mm. Width of arm close to disk 1·5 mm. Four short tooth-like mouth papillæ on each side, with one larger at apex of jaw. Mouth shields pentagonal; outer and lateral sides straight, with very blunt angle within; outer corners rounded; length to breadth 1·3 : 1. Side mouth shields narrow, with a wavy outline, meeting within. First under arm plate triangular, with an angle within and outer side curved; second plate longer, with inner angle truncated; beyond this they are pentagonal, with outer side curved, lateral sides re-enteringly curved, and an angle within. Side arm plates broad, meeting below, but separated above, near base of arm, by the upper arm plates, which are long wedge-shaped, with outer edge curved, and an angle within, except the first two, which have the inner angle truncated. Disk angular, covered with large, much swollen plates, having deep furrows between them; in centre a group of six primary plates, separated by a row of irregular smaller plates; outside of these is another circle of ten equally large plates, of which the brachial ones separate the inner ends of the radial shields. In each interbrachial space there is also a large marginal plate. Radial shields longer than broad, outer edge much wider than inner, joined without, but widely separated within by a large rounded plate. Length to breadth 2 : 1. On the under surface the plates are not so much swollen, and more regular; in each interbrachial space are about three concentric rows, of from three to five plates each. Genital plates long and rather wide, with outer end wider than inner;

along the free edge is a close row of fine, even, tooth-like papillæ, which become somewhat longer and wider as they pass upward to form the arm comb. Three arm spines short, blunt, and equally distant from each other. On first two sets of pores four tentacle scales on each side; the third has three on each side; the fourth, one on the outside and three on the inside; a little beyond the disk there is only one on the inside. Colour in alcohol, white.

Station 169.—July 10, 1874; lat. 37° 34′ S., long. 179° 22′ E.; 700 fathoms; grey ooze.

Ophioglypha ponderosa, Lym. (Pl. VII. figs. 7–9).

Ophioglypha ponderosa, Lym., Bull. Mus. Comp. Zool., vol. v., part 7, p. 93, pl. ii. figs. 52–54, 1878.

Disk plates high and excessively swollen. Upper arm plates rising in a high sharp ridge. Arm spines minute, close set, and like little blocks.

(Type specimen from Station 232.) Diameter of disk 32 mm. Width of arm at disk 6 mm. Mouth papillæ square, flat, crowded, forming a continuous row with the scales of the mouth tentacles, four or five on each side, with three or four longer and pointed papillæ at angle of jaw. Mouth shield long and narrow, with outer end much rounded, lateral sides having a slightly re-entering curve, and a short blunt angle within; length to breadth 5·7 : 3. Side mouth shields long triangular, outer edges broader; inner ends tapering, where they meet. Under arm plates broad hexagonal, with outer and inner ends straight, and short angles on the sides; the first plate is similar, but not so large as the others; farther out on the arm they become diamond-shaped. Side arm plates swollen, with outer edge curved, not meeting either above or below. Upper arm plates narrow, very highly arched, forming a sharp ridge; length to breadth about equal, wider without than within, four sided, with sides nearly straight. The upper surface of disk is covered by angular plates, excessively swollen and lumpy, and compactly soldered; the plates in centre being smallest. Radial shields longer than wide, with edges irregularly curved, meeting without, diverging inward, where they are separated by a large plate of about the same size and shape; in the interbrachial space, besides numerous smaller plates, is one roughly triangular, with one angle inward; on the lower interbrachial space the scales are not so much swollen; there are about half a dozen, besides the genital plates, which are composed of three pieces, the outer one being the largest and thickest; along their entire edge from the mouth shield to the outer edges of the radial shields is a row of fine, square, short papillæ, those nearest the mouth shield being broader than long, while towards the radial shields they become very fine, and much narrower than long;

there is a group of similar papillæ on the free outer end of the side mouth shield. The arm spines are so short, thin, square, and closely soldered together as to look like a continuous narrow border to the side arm plate; in shape they resemble the arm comb, and are about eight in number. The pores of the mouth tentacles have four or five scales on each side, similar to the mouth papillæ; the second has seven similar scales on the interbrachial side, and four on the other; the third five and four; the fourth four and three; beyond this three only on the inner or interbrachial side. Colour in alcohol, brownish-yellow.

Station 232.—May 12, 1875, off Enosima, Japan; lat. 35° 11′ N., long. 139° 28′ E.; 345 fathoms; sandy mud.

Ophioglypha minuta, Lym. (Pl. VII. figs. 10–12).

Ophioglypha minuta, Lym., Bull. Mus. Comp. Zool., vol. v., part 7, p. 94, pl. v. figs. 117–119, 1878.

Interbrachial space below covered by only one or two plates besides the genital scales. Upper arm plates rudimentary or wanting. Tentacle pores of arm with only one rounded scale.

(Type specimen from Station 158.) Diameter of disk 5·5 mm. Length of arm about 12 mm. Width of arm close to disk, without spines, 1 mm. Six short, squarish, closely set, longer than wide mouth papillæ on sides of angle, and three short and bluntly pointed at apex of jaw. Mouth shield as long as broad, having a slight constriction towards the inner end, which is an obtuse angle, outer side widely curved; length to breadth 1 : 1. Side mouth shields longer than wide, meeting within, and there forming a long angle inward; outer edges narrower than inner. First under arm plate triangular, with rounded angle inward, lateral sides having a slight re-entering curve, and outer edge gently curved. Second under arm plate pentagonal, length and breadth about equal, having deep re-entering curves on the lateral sides, a narrow obtuse angle within, and outer side curved; beyond the second the plates are triangular in shape, having an angle inward and outer side curved; they become rapidly less in size, and disappear beyond the fifth, though the tentacle pores continue. Side arm plates long and thick, beyond the second under arm plate forming almost the entire covering of the arm, as there are no upper arm plates. Disk flat and round, with a central group of six primary plates, whereof the middle one is pentagonal, while the five surrounding it are transverse oval; connecting these plates are minute triangular scales; the interbrachial spaces above are filled by two large plates, the inner one broader than long, with outer edge straight, and inner edge broader than outer; the marginal plate has the inner edge straight, and the outer

curved; on either side of the marginal plate are two minute semicircular scales. Radial shields three-sided, longer than broad, joined their entire length; outer edges with a slight re-entering curve; interbrachial edges curved; length to breadth 1·5 : 1·3. Interbrachial space below filled by a large slightly swollen plate, which is sometimes divided in two by a median line, and by the large, thick, longer than broad genital scales, along the free edge of which are eight or more very minute, short, blunt papillæ, extending to upper margin of disk, where they bear an arm comb of two or three papillæ. Three short delicate arm spines about two-thirds the length of a joint, two low on the under surface of the arm, and one well up on its side. Tentacle scales on the first set of pores, two on the interbrachial side and one on the brachial; beyond this there is only one large scale on the inner side. Colour in alcohol, white.

The proportionate size of the side arm plates and small number of those of the disk show this to be a young specimen, but its characters are so well marked as to warrant a description; and its great depth gives it importance.

Station 158.—March 7, 1874; lat. 50° 1′ S., long. 123° 4′ E.; 1800 fathoms; globigerina ooze. Station 146.—December 29, 1873; lat. 46° 46′ S., long. 45° 31′ E.; 1375 fathoms; globigerina ooze.

Ophioglypha inermis, Lym. (Pl. VII. figs. 4–6).

Ophioglypha inermis, Lym., Bull. Mus. Comp. Zool., vol. v., part 7, p. 95, pl. v. figs. 123–125, 1878.

No arm comb, and only a feeble row of grains along the genital opening. Disk covered with thin overlapping scales and very small radial shields.

Diameter of disk 14 mm. Length of arm about 70 mm. Width of arm close to disk, without spines, 2·5 mm Mouth papillæ small, short, pointed, and close set, similar to and continuous with the tentacle scales of the second pair of mouth tentacles. If those be true mouth papillæ that stand on the mouth frames, there are eight or ten on either side and a cluster of three somewhat larger on the jaw-plate. Mouth shield broader than long, with very blunt angle inward and outer edge curved; length to breadth 2 : 2·7. Side mouth shields longer than broad, of nearly equal width, nearly or quite meeting within. First under arm plate small, longer than broad, hexagonal; second plate broader than long, rounded quadrangular; beyond this the plates become much broader than long, with sharp angles at the lateral sides, a small peak within, and a rounded angle without. Side arm plates thin, not swollen, just meeting below beyond the fourth under arm plate; separated above by the large upper arm plates, which are much broader than long, and wider without than within, with lateral sides straight, and outer corners rounded.

Disk high and round, covered above and below with very thin, closely overlapping scales, with one minute circular primary plate in centre of disk. Radial shields small, nearly round, separated by a large angular plate; length to breadth 1·3 : 1. Genital scales hidden; along their free edge is a row of very minute, bead-like papillæ; three slim, flat, pointed, nearly equal arm spines, somewhat longer than an arm joint, and equally spaced along the outer edge of the side arm plate. The first pair of tentacle pores, which open into the mouth slit, have six or seven minute tentacle scales, exactly like the mouth papillæ, and arranged in an ox-bow figure. The first arm pores have three minute papillæ on either side; those beyond have only two long and rounded scales on the inner side of each pore. Colour in alcohol, white.

It will be noted that *Ophioglypha inermis* stands on the limit of *Ophioglypha;* while it has the general look and structure of the genus, it lacks wholly the arm comb, and has only a trace of the papillæ along the genital scale below. It seems to go better here than with *Ophiocten.*

Off Tristan d'Acunha; 500 fathoms.

Ophioglypha deshayesi, Lym. (Pl. VII. figs. 13–15; Pl. XXXVIII. figs. 22–25).

Ophioglypha deshayesi, Lym., Bull. Mus. Comp. Zool., vol. v., part 7, p. 96, pl. ii. figs. 35–37, 1878.

Side mouth shields large and ovoid. Radial shields and primary plates circular and similar. Disk and arm plates thick, swollen, and closely soldered. Mouth papillæ and scales of mouth tentacles thick, squarish, irregular, and crowded. No proper arm comb.

(Type specimen from Station 151.) Diameter of disk 18 mm. Length of arm 80 mm. Width of arm close to disk 4 mm. Mouth papillæ irregular, crowded, angular, closely soldered, five or six on each side and usually one or two at apex of jaw. Mouth shields small, with long, acute angle inward, and outer edge cleanly curved; length to breadth 3 : 2. Side mouth shields large, narrow pear-seed shape, with the rounded ends inward, where they meet at one point. Inside the junction of the side mouth shields is a small diamond-shaped supplementary plate, which makes the apex of an angle. First under arm plate semi-circular or transverse oval, with outer edge nearly straight; the plates beyond are wide triangular, with a truncated angle inward, and outer side a little curved. Side arm plates swollen, nearly meeting below within the disk; separated above by the upper arm plates, which are broader than long, arched, wider without than within, hexagonal, having outer angles more or less rounded. Disk very thick, covered with rounded plates somewhat obscured by a thick skin; in the centre above are six large primary plates separated by

one or two rows of smaller ones, and in the interbrachial spaces are two larger plates, one marginal and the other inside it. Radial shields very nearly round, separated usually by three plates in a line; length to breadth 3 : 3; along their inner margin is a row of small irregular-shaped scales. Genital plates formed of two or more pieces, wider without, tapering inward; along the outer portion of their free edge is a row of small shapeless pieces, which become more numerous above, and there form a sort of arm comb. One minute papilla-like arm spine situated near the junction with the upper arm plate. Pores of mouth tentacles enclosed on one side by the two outer mouth papillæ, with some other minute pieces; and on the other side by four or five similar parts, which correspond to tentacle scales: the rest of the pores stand near the lateral corners of the under arm plates, and have three small peg-like tentacle scales. Colour in alcohol, yellowish-brown or grey.

This species clearly exhibits the homology between side mouth shields and side arm plates.

Station 150.—February 2, 1874; lat. 52° 4′ S., long. 71° 22′ E.; 150 fathoms; rock. Station 151.—February 7, 1874; off Heard Island; 75 fathoms; mud. Christmas Harbour, Kerguelen Islands, 120 fathoms. Royal Sound, Kerguelen Islands, 28 fathoms.

Ophioglypha inornata, Lym. (Pl. III. figs. 10–12).

Ophioglypha inornata, Lym., Bull. Mus. Comp. Zool., vol. v., part 7, p. 97, pl. ii. figs. 26, 27.

Side mouth shields small. Mouth shield broader than long, with a peak inward. Disk and arm plates thick, swollen, and closely soldered. Mouth papillæ and scales of mouth tentacles thick, squarish, irregular, and crowded.

(Type specimen from Station 106.) Diameter of disk 10 mm. Length of arm about 23 mm. Width of arm close to disk, without spines, 2 mm. Five or six short, bead-like, closely soldered mouth papillæ on each side, with one much longer at apex of jaw. Mouth shields broader than long, small, rounded triangular, with angle inward, and outer edge curved. Side mouth shields short, pointed oval, occupying inner sides of the mouth shield and meeting broadly within. First under arm plate rounded, with a long curve within and an obtuse angle without; second pentagonal, with an angle inward, outer side wide, and laterals re-enteringly curved; beyond these the plates become broader than long, with an angle within and a curve without. Side arm plates thick, slightly swollen, meeting broadly below; separated above by upper arm plates, which are thick, rather small, of a rounded diamond shape, and as long as broad. Disk rather thick, swollen, covered with thick,

minutely tuberculous plates. Radial shields irregular in form, inner edges nearly circular or oval, diverging inward, where they are separated by a single row of three scales; in each interbrachial space is a marginal plate connecting the radial shields. In centre of disk above are six round, well-marked primary plates, separated from each other and from the radial shield by single lines of much smaller plates. Interbrachial space below covered chiefly by a large marginal plate, and two smaller between it and the mouth shield. Genital plates short, thick, broader within, tapering outward, where they bear small, irregularly placed papillæ, which make above a sort of arm comb. Arm spines minute and hard to see, one near upper arm plate and two or three near the under. Tentacle scales minute; on the pores of the mouth tentacles are four on one side and three on the other; the second pore, which is near the inner end of the arm plate, has only three; and the third two. Colour in alcohol, grey.

Station 106.—August 25, 1873; lat. 1° 47′ N., long. 24° 26′ W.; 1850 fathoms; globigerina ooze.

Ophioglypha confragosa, Lym. (Pl. VIII. figs. 7–9).

Ophioglypha confragosa, Lym., Bull. Mus. Comp. Zool., vol. v., pt. 7, p. 97, pl. ii. figs. 38, 39, 57, 1878.

Disk plates irregular and humpy. A group of papillæ near the arm, on margin of interbrachial space. Disk and arm plates thick, swollen, and closely soldered. Mouth papillæ and scales of mouth tentacles thick, squarish, irregular, and crowded.

(Type specimen from Station 320.) Diameter of disk 14 mm. Width of arm close to disk 2·3 mm. Mouth papillæ angular, closely soldered, four or five on each side, and one, diamond-shaped, at angle of jaw. Mouth shield large, five-sided, with blunt angle inward, and outer edge slightly curved; length to breadth 2·3 : 2. Side mouth shields narrow, of about even width, running along inner angle of mouth shield and meeting within. First under arm plate three sided, with inner sides much curved and outer edge nearly straight; second and third also three-sided, having two re-entering curves on the lateral sides; beyond this they become broader than long, with outer edge so much curved as to give them a diamond-shaped appearance. Side arm plates swollen, just meeting below and separated above by upper arm plates, which are rounded, with outer and inner edges slightly flattened; farther out they become long hexagonal, with corners much rounded. Disk flat, covered with rounded raised plates, separated by deep furrows; in the centre are six primary plates surrounded by a row of smaller and more angular. In each interbrachial space above are two large plates, one on the margin. Radial shields blunt pear-seed shape, with the rounded end outward, separated widely by one large and one small plate. Genital plates composed of two or three pieces, the outer and principal

piece long and narrow, tapering at each end, of which the outer is covered by a clump of small soldered papillæ, which pass upward and form a sort of arm comb. The rest of the lower interbrachial space is covered by five large and as many small plates. Arm spines minute and peg-like, one half-way up the side arm plate, and one near the junction of the upper arm plate with the side arm plate. Three large, square, close-set tentacle scales on either side of pores of mouth tentacles; on the second pair one peg-like scale, and on the rest two similar scales. Colour in alcohol, white.

Station 320.—February 14, 1876; lat. 37° 17′ S., long. 53° 52′ W.; 600 fathoms; hard ground.

Ophioglypha intorta, Lym. (Pl. VIII. figs. 13–15).

Ophioglypha intorta, Lym., Bull. Mus. Comp. Zool., vol. v., part 7, p. 98, pl. ii. figs. 41–43, 1878.

Side mouth shields very narrow. A small arm comb. Disk and arm plates thick, swollen, and closely soldered. Mouth papillæ and scales of mouth tentacles thick, squarish, irregular, and crowded.

Diameter of disk 9 mm. Length of arm 23 mm. Width of arm at disk 1·5 mm. Mouth papillæ angular, closely soldered, five or six on each side, and a larger, diamond-shaped, at angle of jaw. Mouth shield large, pentagonal, with a long angle within and outer edge rounded. Side mouth shields long, narrow, curved, and tapering towards either end, scarcely meeting within. First under arm plate triangular, with one angle inward, outer edge straight, and lateral sides curved; those beyond are wide pentagonal, with an angle within, and outer side a little curved. Side arm plates short and stout, scarcely meeting below within the disk, and separated above by the upper arm plates, which are swollen, broader than long, broader without than within, with a curved outer edge. Disk flat, covered with raised, irregularly shaped, angular plates, having deep furrows between them. Radial shields ovoid in outline, with the smaller end inward, separated by a wedge of three or four plates. Genital plates long and narrow, much wider without than within; along their free edge is a row of fine, short, upright papillæ, which pass upward and form an arm comb. Two short, thick, and blunt arm spines, one at centre of edge of the side arm plate, and another near junction of the upper arm plate. The pores of the mouth tentacles have three or four scales like mouth papillæ on each side; beyond there are two scales shaped like the arm spines. Colour in alcohol, light grey.

Off Marion Island; 50 to 75 fathoms.

Species of *Ophioglypha* not herein described.

Ophioglypha ciliata, Ljn., Dr. Goës. Oph., Öf. Kong. Akad., p. 651, 1871.

Stella lumbricalis lacertosa, Linck., De Stell. Mar., 1733, pl. ii. No. 4, p. 47; Knorr, Deliciæ Nat. Select., pl. G. 1, figs. 1, 2, 1771.
Asterias ophiura, O. F. Müll., Zool. Dan. Prodr., p. 235.
Asterias ciliata, Retz, Diss., p. 29, 1805.
Ophiura texturata [pars], Lmk., Hist. Anim. sans Vert., p. 542.
Ophiura aurora, Risso, His. Nat., p. 273, vol. v. fig. 29.
Asterias cordifera, Delle Chiaje, Mem., vol. ii. p. 358, pl. xx. fig. 12.
Ophiura bracteata (?), Johnston, Mag. of Nat. Hist., vol. iii. p. 467.
Ophiura texturata, Fbs., Wern. Mem., vol. viii. p. 125, pl. iv. figs. 3, 4; Brit. Starfishes, p. 22.
Ophiolepis ciliata, Müll. & Tr., Syst. Ast., p. 91.
Ophiura texturata, Ltk., Addit. at Hist., part 1, p. 36, pl. i. figs. 1ª, 1ᵉ.
Ophioglypha lacertosa, Lym., Ill. Cat. Mus. Comp. Zool., No. i. p. 40; Ludwig, Echin. des Mittelmeeres, p. 546.

North European Seas; Mediterranean; 5 to 100 fathoms.

Ophioglypha carnea, Lym., Ill. Cat. Mus. Comp. Zool., No. i. p. 10, 1865.

Ophiura carnea, Sars, MS.; Ltk., Addit. ad Hist., part 1, p. 41, pl. i. figs. 6 *a*, *b*.

North European Seas; 40 to 300 fathoms.

Ophioglypha albida, Lym., Ill. Cat. Mus. Comp. Zool., No. i. p. 49, 1865. Ludwig, Anatomie der Ophiuren Zeits. für Wissen. Zoologie, vol. xxxi. p. 241; Echin. des Mittelmeeres, p. 547.

Ophiura texturata [pars], Lmk., Hist. Anim. sans Vert., vol. ii. p. 542, 1816.
Ophiura albida, Fbs., Wern. Trans., vol. viii. p. 125, pl. iv. figs. 5, 6; Brit. Starfishes, p. 27, Ltk., Addit. ad Hist., part 1, p. 39, pl. i. figs. 2 *a*, *b*.

North European Seas; Mediterranean; 5 to 250 fathoms.

Ophioglypha arctica, Lym.

Ophiura arctica, Ltk., Vid. Meddel., 1854, p. 7.
Ophioglypha sarsii, Stuxberg, Öf. Kong. Akad., 1878.

Ophioglypha lütkeni, Lym., Proc. Best. Soc. N. H., vol. vii. p. 197, 1860; Ill. Cat. Mus. Comp. Zool. No. i. p. 47; Ill. Cat. Mus. Comp. Zool., vol. viii., part 2, p. 4.

Puget Sound to Santa Barbara, Cal.; 22 to 111 fathoms.

Ophioglypha affinis, Lym., Ill. Cat. Mus. Comp. Zool., No. i. p. 52, 1865. Ludwig, Echin. des Mittelmeeres, p. 547.

Ophiura affinis, Ltk., Addit. ad Hist., part 1, p. 45, pl. ii. figs. 10 *a*, *b*, 1858.
Ophiura Normani, Hodge, Trans. Tyneside N. F. Club, vol. v., part 4, p. 296.
Ophiura Grubei, Heller, Lit. Fauna d. Adriat. Meeres, p. 431, pl. ii. figs. 13–16, 1862.

North European Sea; Adriatic Sea; N. E. America; 20 to 192 fathoms.

Ophioglypha robusta, Lym., Ill. Cat. Mus. Comp. Zool., No. i. p. 45, 1865.

(?) *Asterias Tenorii*, Delle Chiaje, Mem. vol. ii. p. 371, pl. xxi. figs. 7–11.
(?) *Ophiolepis Tenorii*, Müll. & Tr., Syst. Ast., p. 93.
Ophiolepis robusta, Ayr., Proc. Bost. Soc. N. H., vol. iv. p. 134, 1851.
Ophiura fasciculata, Fbs., Sutherland Journ. Voy. Baffin's Bay, vol. ii. p. ccix., 1852.
Ophiura squamosa, Ltk., Vid. Meddel., Nov. 1854, p. 6; Addit. ad Hist., part 1, p. 46, tab. i. fig. 7 *a*, *b*.
Ophioglypha Tenorii, Ljn., Oph. Viv. Öf. Kong. Akad., p. 306, 1866.
Ophiura Tenorii, Heller, Lit. Fauna d. Adriat. Meeres, p. 428.

European Arctic Ocean; North Europe; Greenland; N. E. America.

Ophioglypha Forbesii, Duncan, Journ. Linn. Soc., vol. xiv. p. 449, pl. ix. figs. 1–3, 1879.

Korean Sea; 51 fathoms.

Ophioglypha sladeni, Duncan, Journ. Linn. Soc., vol. xiv. p. 458, pl. ix. figs. 9–11, 1879.

Korean Sea.

Ophioglypha striata, Duncan, Journ. Linn. Soc., vol. xiv. p. 452, pl. ix. figs. 4, 5, 5ª, 1879.

Korean Sea.

Ophioglypha sculpta, Duncan, Journ. Linn. Soc., vol. xiv. p. 455, pls. ix. and xi. figs. 6, 7, and 35, 1879.

Korean Sea; 23 fathoms.

Ophioglypha stuwitzii, Lym., Ill. Cat. Mus. Comp. Zool., No. i. p. 51, 1865.

Ophiura Stuwitzii, Ltk., Grön. Echin. Vid. Meddel., p. 51, 1857; Addit. ad Hist., part 1, p. 49, pl. i. figs. 8 *a*, *b*, 1858.

Greenland; Newfoundland; 30 fathoms.

Ophioglypha nodosa, Lym., Ill. Cat. Mus. Comp. Zool., No. i. p. 49, 1865.

Ophiura nodosa, Ltk., Vid. Meddel., p. 6, Nov. 1854; Addit. ad Hist., part 1, p. 48, pl. ii. fig. 9 *a*, *b*, 1858.

Greenland; Labrador; 12 to 50 fathoms.

Ophiocten.

Ophiocten, Ltk., Vid. Meddel., 1854.

Disk thick and circular, without notches where the arms join it; partly covered by primary plates and radial shields, between which are sometimes fine, close-set grains, or small scales, covering the squamous coat; on the interbrachial spaces below, a simple squamous coat, without any covering of grains. A row of papillæ, passing along the genital openings and sometimes upwards, along the margin of the disk, over the arm. Side arm plates meeting below but not above. The second mouth tentacle is enclosed between the first under arm plate and the outer end of the side mouth shield. Teeth. Mouth papillæ. No tooth papillæ. Two genital openings, beginning at the sides of the mouth shields.

In respect to radial shields, coarse disk plates, and form of mouth angles, this genus resembles the typical *Ophioglypha*, but the whole structure is lighter and more slender. The genital plates are long, slim and scarcely clubbed at their outer end, to which is attached a short, thin, genital scale. The arm bones are wider than high and have, above, a small process running forward. There is a small, but well-marked transverse oval peristomial plate.

See Plate XXXVIII. figs. 18–21.

Table of Species of *Ophiocten*.

Region between primary plates, on back of disk, occupied by a close flat granulation or minute scaling. Besides the double arm comb, the basal upper arm plates have a row of papillæ along their outer edge, ...	*Ophiocten sericeum.*
Similar to preceding, but upper arm plates have no papillæ, . . .	*Ophiocten abyssicolum.*
Scattered granules on the upper surface of disk. Arm comb continued by small spines along margin of disk, ...	*Ophiocten depressum.*
Arm comb as in *Ophiocten sericeum*. Primary plates rounded and conspicuous and separated by imbricated scales, ...	*Ophiocten amitinum.*
Arm comb somewhat as in preceding. Upper arm spine as long as three joints; the two lowest as long as one joint, ...	*Ophiocten hastatum.*
Comb only along genital openings. Primary plates small and round, . .	*Ophiocten umbraticum.*
No arm comb. Disk covered with minute scales, among which a few small, widely separated primary plates, ...	*Ophiocten pallidum.*

Ophiocten sericeum (?), Ljn. (Pl. XXXVIII. figs. 18–21).

Ophiocten sericeum, Ljn., Tilläg Skan. Oph. Öf. Kong. Akad., p. 360, 1864; Lym., Bull. Mus. Comp. Zool., vol. v. p. 7, pl. 102.
Ophiocten Kröyeri, Ltk., Vid. Meddel., p. 8, 1854; Addit. ad Hist., part 1, p. 52, pl. i. figs. 5^a–5^d; Lym, Ill. Cat. Mus. Comp. Zool., No. i. p. 53.
Ophiura sericea, Fbs., Suth. Journ. Voy. Baffin's Bay, vol. ii., App.
Ophioglypha gracilis (?), G. O. Sars (young), Vid. Selsk. Forh., p. 18, 1871.

Ophiocten sericeum seems not to differ essentially from *Ophioglypha gracilis*, except in having a comb of fine papillæ along the outer edges of the basal upper arm plates; but this comb is wanting in the young, and not regular in the adult. A young *Ophiocten sericeum* (disk 7·5 mm.) was very like a still smaller *Ophioglypha gracilis* (disk 6·8 mm.), which had the arm comb less marked; but other specimens had it just the same. A number of specimens marked as *Ophiocten sericeum* (young) and *Ophioglypha gracilis* showed variations in number of papillæ along the genital openings, coarseness of disk scales, more or less pointed tentacle scales, and length of spines; but all these variations seem common to both, in a greater or less degree. The two specimens of the Challenger Expedition showed no valid difference with the half-grown *Ophiocten sericeum*, except in absence of papillæ along the genital opening; but two specimens from George's Bank, off Massachusetts, were in this respect intermediate, and had hardly any papillæ in that region.

Off Marion Island; 50 to 75 fathoms.

Ophiocten amitinum, Lym. (Pl. IX. figs. 7–9).

Ophiocten amitinum, Lym., Bull. Mus. Comp. Zool., vol. v. part 7, p. 100, pl. v. figs. 129, 130, 1878.

Primary and marginal disk plates large and conspicuous. Arm comb and papillæ on first two upper arm plates well marked. Two minute tentacle scales.

(Type specimen from Kerguelen Island.) Diameter of disk 7 mm. Length of arm about 35 mm. Width of arm without spines 1·5 mm. Four short blunt mouth papillæ on each side, and one longer and pointed at apex of jaw. Mouth shield large, pentagonal, broader within than without, having a wide angle within, and outer corners curved; length to breadth 1·3 : 1·4. Side mouth shields small, broader without than within, where they meet and are often somewhat separated from the mouth shield. First under arm plate large, rounded triangular, with outer edge straight; the remaining plates small and three-sided, much wider than long, with outer edges strongly curved and inner laterals re-enteringly curved, the whole presenting almost a crescent shape; they become very small towards tip of arm. Side arm plates broad, flaring somewhat outward, meeting broadly below; separated above by the upper arm plates, which are broader than long, with lateral sides straight, and outer edge, which is

wider than inner, curved. Disk round, flat, and rather thick, covered with thin flat scales and plates of various sizes, among which are six rounded primaries, separated by single lines of small scales; in the brachial space, just inside the radial shields, there is a transverse row of larger rounded scales; in each interbrachial space are two separated plates similar to the primaries, and outside these, along margin of disk, is a row of four connected plates. Radial shields conspicuous, pear-seed shaped, widely separated by disk scales. Outside the radial shields is an arm comb of small, short pointed papillæ, a part carried on outer point of genital scale and a part on outer edge of radial shield and on the scale between the radial shields; besides these there is on the outer edge of the first three upper arm plates a row of from three to five papillæ. Lower interbrachial space covered by regular rows of small, semicircular, overlapping scales, and by the genital scales, which are longer than broad, and slightly wider without than within, and sometimes carry on their free edge an irregular row of minute papillæ. First pair of tentacle pores have two very small scales on the outer edge, the rest have one on each side. Three long, slender, cylindrical, sharp, tapering arm spines, situated close together low on the outer edge of the side arm plates; lengths to that of an arm joint 1·2, ·8, ·6 : ·6. Colour in alcohol, white. The upper arm plate comb is variable. The tentacle scales easily drop off.

One young, with a disk of 3 mm., differed in having the upper disk covered almost entirely by the primary and the other large plates; the intermediate disk scales were just beginning to form. The radial shields were shorter, and the papillæ above the arm fewer.

Kerguelen Islands; 120 fathoms. Prince Edward's Island; 85–150 fathoms (same species?). Station 152.—February 11, 1874; lat. 60° 52′ S., long. 80° 20′ E.; 1260 fathoms; diatom ooze. Station 146.—December 29, 1873; lat. 46° 46′ S., long. 45° 31′ E.; 1375 fathoms; globigerina ooze. Station 157.—March 3, 1874; lat. 53° 55′ S., long. 108° 35′ E.; 1950 fathoms; diatom ooze.

Ophiocten pallidum, Lym. (Pl. IX. figs. 4–6).

Ophiocten pallidum, Lym., Bull. Mus. Comp. Zool., vol. v., part 7, p. 102, pl. v. figs. 126–128, 1878.

Disk covered with minute thin scales, among which appear very small, widely separated primary plates. One minute tentacle scale. Three short, equal, slender arm spines.

(Type specimen from Station 160.) Diameter of disk 14·5 mm. Length of arm about 70 mm. Width of arm close to disk, without spines, 1·7 mm. Five short, blunt, ill-defined mouth papillæ on the side, and one larger at apex of jaw, like the three or four teeth that stand immediately above it. Mouth shields much broader than long, bounded on the outer edge by a wide curve and by a very wide angle within; length to breadth

1·2 : 2·6. Side mouth shields long and narrow, extending along the inner angle of the mouth shield, and just meeting within, where they broaden slightly, becoming narrower at the outer end where attached to the side arm plate. First under arm plate much larger than the others, four sided, with outer edge straight, lateral sides re-enteringly curved, and a short side, like a truncated angle within; the rest of the under arm plates are very small, with a curved outer side, and are nearly semicircular in form, but have a slight peak inward at the junction of the side arm plates, which are thin and wide, flaring slightly outward, meeting broadly below, and separated above by the upper arm plates, which are four sided, with outer edge nearly straight and wider than inner. Disk round, smooth, and flat, covered with minute, very thin, overlapping scales, four or five in the length of a millimetre on upper surface, and more below; among them may be distinguished small, round, widely separated primary plates. Radial shields longer than broad, three sided, with all three angles much rounded, widely separated their entire length by the disk scaling; length to breadth 2·6 : 1·5. Genital scales hidden, except the outer tip, which shows outside the radial shield, and bears no papillæ, or only one or two rudimentary. Three sharp, slender, tapering arm spines, situated close to each other on the middle edge of the side arm plate. Only one very minute, rounded tentacle scale on the outer edge of some of the tentacle pores; a little way out on the arm there is usually a minute scale on the inside of the pore, and none on the outer side. Colour in alcohol, pale straw.

Beyond the disk there is almost always a tentacle scale, which is often lacking in the basal joints. The little papilla outside the pore is also frequently wanting. Some specimens have a small arm comb, and even a feeble one on the basal upper arm plate.

Station 156.—February 26, 1874; lat. 62° 26′ S., long. 95° 44′ E.; 1975 fathoms; diatom ooze. Station 160.—March 13, 1874; lat. 42° 42′ S., long. 134° 10′ E.; 2600 fathoms; red clay.

Ophiocten umbraticum, Lym. (Pl. IX. figs. 1–3).

Ophiocten umbraticum, Lym., Bull. Mus. Comp. Zool., vol. v., part 7, p. 101, pl. v. figs. 131, 132, 1878.

Primary and marginal disk plates small, and the former widely separated. Arm comb feeble. Tentacle scales single and minute, or quite wanting.

(Type specimen from Station 325.) Diameter of disk 9·5 mm. Width of arm close to disk, without spines, 1·3 mm. Four rather wide, closely-joined mouth papillæ, with one larger, diamond-shaped, at apex of the jaw. Mouth shield, very thin, triangular, broader than long, with blunt angle inward and corners rounded; length to breadth 1 : 1·5. Side mouth shields long and narrow, tapering inward, where they nearly or quite meet. First under arm plate large, four sided, the inner side being very short like a

truncated angle, with corners rounded; the rest of the under arm plates are very small, nearly or quite semicircular, with a little peak inward. Side arm plates slightly flaring outward, meeting broadly below, where they form most of the under surface of the arm; separated above by upper arm plates, which are four sided, with outer edge wider than inner, and curved; lateral sides slightly re-enteringly curved. Disk flat and thin, covered with small, transparent, delicate scales; six small, rounded, widely separated primaries, one in the centre and one to each brachial space; outside these there are two similar plates in each interbrachial space, one towards the centre and one near the margin; along the margin there are two irregular rows of small plates, somewhat broader than long. Radial shields triangular, with a rounded angle inward, widely separated by the disk scaling; length to breadth 1·5 : 8. Lower interbrachial space covered by delicate, nearly transparent scaling, which also hides the genital scales, except their outer tips, just outside the radial shields, which bear an arm comb of three or four minute papillæ. Genital opening quite long, extending from the outer end of side mouth shields to edge of disk. There are large tentacle pores, but no scales on any of the pores. Near base of arm there are three small, delicately tapering arm spines, situated on the outer edge of the side arm plate; the upper is about two-thirds the length of an arm joint, and the lowest about half as long; farther out there are but two spines. Colour in alcohol, white.

On the above specimen no tentacle scales could be seen, but on others some pores, at any rate, are furnished with a single minute one.

Station 325.—March 2, 1876; lat. 36° 44′ S., long. 46° 16′ E.; 2650 fathoms; grey mud.

Ophiocten hastatum, Lym. (Pl. IX. figs. 10, 11).

Ophiocten hastatum, Lym., Bull. Mus. Comp. Zool., vol. v., part 7, p. 103, pl. v. figs, 133, 134, 1878.

Disk with minute thin scales, among which appear well-marked primary plates. Three tapering arm spines, the upper much the longest and largest. One minute tentacle scale.

(Type specimen from Station 146.) Diameter of disk 9 mm. Width of arm close to disk 2 mm. Four or five short, squarish, close-set mouth papillæ on each side, with one much larger at apex of jaw, having two small bead-like ones at its base. Mouth shield rounded pentagonal, having a broad angle within. Side mouth shields long and narrow, of about equal width, nearly or quite meeting within. First under arm plate larger than any of the others, four-sided, with inner side much narrower than the outer, which is slightly rounded; the remainder of the under arm plates are much wider than long, and nearly semicircular, with a slight peak inward, and outer side strongly curved. Side arm plates

somewhat swollen and flaring outward, meeting broadly below; separated above by the upper arm plates, which are somewhat arched, with the inner side narrower than the outer, which is curved. Disk round, smooth, and flat, covered above and below with minute thin scales; in the centre are several rounded primary plates, and one of nearly equal size in each interbrachial space. Radial shields pear-seed shape, with inner angle blunt, and outer corners rounded; separated their entire length by fine overlapping scales. Genital scales hidden, except their tips, outside the radial shields, which bear an arm comb of a few minute papillæ, as does sometimes the first upper arm plate. Three slender, cylindrical, tapering, pointed arm spines, the upper one being much longer and larger than the two lower; lengths to that of an arm joint 3·4, 1, ·8 : 1. Tentacle scales minute and rounded; there are two or three to each of the second mouth tentacles; usually one on the outside of the basal pores, and one on the inside of the pores farther out on the arm. Colour in alcohol, disk nearly white; arms above pale grey. It is in general like *Ophiocten pallidum*, but the flatter and wider arms bear a very long upper arm spine.

Station 78.—July 10, 1873; lat. 37° 24′ N., long. 25° 13′ W.; 1000 fathoms; globigerina ooze. Station 146.—December 29, 1873; lat. 46° 46′ S., long. 45° 31′ E.; 1375 fathoms; globigerina ooze. Station 168.—July 8, 1874; lat. 40° 28′ S., long. 177° 43′ E.; 1100 fathoms; grey ooze.

Species of *Ophiocten* not herein described.

Ophiocten abyssicolum, Ltk., Addit. ad Hist., part 1, p. 51, 1868. Ludwig, Echin des Mittelmeeres, p. 548.

Ophiura abyssicola, Fbs., Linn. Trans., vol. xix. p. 146, pl. xiii. fig. 8, 1843.

Ægean Sea; 150–200 fathoms.

Ophiocten depressum, Lym., Bull. Mus. Comp. Zool., vol. i., part 10, p. 320, 1869; Ill. Cat. Mus. Comp. Zool., No. vi., pl. ii. fig. 10.

Florida; 315 fathoms.

Ophiomusium.

Ophiomusium, Lym., Bull. Mus. Comp. Zool., vol. i., part 10, 1869.

Teeth; no tooth papillæ; mouth papillæ soldered in a continuous row, so that their former outlines are scarcely to be seen. Disk covered by plates and radial shields, all of which are intimately soldered, forming a surface like porcelain. Upper and under arm plates minute; side arm plates meeting above and below; swelled, intimately soldered

with the neighbouring parts. No tentacle pores beyond the basal arm-joints. Small arm spines on outer edge of arm plates. Two genital openings in each interbrachial space.

In the nature of its covering, this singular genus has some affinity with *Ophiolepis*, as now restricted. But it is almost unique in having no tentacle pores on the greater part of the arm.

Seen from within the disk is heavily plated, and has radial shields so large and wide as nearly or quite to make a complete circle round the disk margin. The genital plate and scale are invariably stout and massive, and the latter is so large in *Ophiomusium pulchellum* as to occupy one-half the lower interbrachial space. In *Ophiomusium flabellum* where the lower interbrachial space is occupied by the opposite side arm plates, the structure of the genital plate and scale is not known. The mouth frames are flaring and the jaws elongated, so as to occupy an unusual proportion of the disk. There may be either an elementary peristomial plate divided in two parts, or none at all. The arm bones, already somewhat elongated within the disk, are still more so just outside of it, and have a central constriction which gives them, in profile, somewhat the outline of a dice-box.

See Plate XXXIX. figs. 10–13.

TABLE OF SPECIES OF *Ophiomusium*.

Arms rather slender and tapering; cylindrical, or but slightly wavy from the gentle swelling of the side arm plates. Upper and under arm plates persisting nearly to end of arm; but no tentacles beyond third or fourth under plate. Mouth shields small. Genital opening bounded by small close-set papillæ.

Disk scales numerous and rather flat, with a large one on the margin. Two or three short, stout arm spines. Side mouth shields long and large,	*Ophiomusium eburneum.*
Interbrachial space between radial shields occupied by two large plates. Papillæ along genital openings extending upward as a small arm comb. Four or five small arm spines,	*Ophiomusium serratum.*
Papillæ on genital openings extending upward as a small arm comb. Side mouth shields small and short. Upper arm plates comparatively large, some of the basal ones inclining to hexagonal. Three or four small arm spines,	*Ophiomusium armigerum.*
Disk thick. Side mouth shields and under arm plates much swollen. Outer mouth papillæ much larger than inner. Genital papillæ large and bead-like. Six or seven small arm spines.	*Ophiomusium corticosum.*
Disk flat, covered with imbricated scales, which are nearly equal, except the marginal, which are larger. Upper arm plates large, the basal ones long hexagonal,	*Ophiomusium cancellatum.*
Disk covered by thick skin: its upper surface occupied chiefly (and in half grown specimens almost entirely), by radial shields and large primary plates, with small scales between. Arms even and cylindrical. Four minute rudimentary arm spines,	*Ophiomusium archaster.*

Table of Species of *Ophiomusium*—continued.

Disk covered by large radial shields, and small irregular scales, among which the primary plates are scarcely conspicuous, ...		*Ophiomusium planum.*
Several flat angular plates in lower interbrachial space besides the large one joining the mouth shield. Genital scales wide. No under arm plates beyond the second or third, ...		*Ophiomusium lymani.*
Upper disk covered by large swollen radial shields, with minute imbricated scaling in centre. Arms wide and thick, with side arm plates much swollen and rounded. Upper arm plates broad diamond-shape, . . .		*Ophiomusium laqueatum.*
Disk covered by large angular swollen plates, of which the interbrachial marginal is largest. Arms wide and thick, with side arm plates much swollen and rounded, and bearing a spine on their upper surface, . .	Upper disk plates bearing large tubercles, . . .	*Ophiomusium acuferum.*
	Upper disk plates smooth, .	*Ophiomusium lütkeni.*
Most of the lower interbrachial space outside the mouth shield is occupied by broad genital scales and a great central plate. No under arm plates beyond the third.	Four small, equally spaced arm spines. Small upper arm plates. The great lower interbrachial plate has usually two, much smaller at its outer corners, ...	*Ophiomusium validum.*
	Two minute arm spines set low down. Besides the great interbrachial plate below, there are three others along the margin, . .	*Ophiomusium simplex.*
	Two minute arm spines set back from edge of plate. Only one lower interbrachial plate, .	*Ophiomusium lunare.*
	Three short, stout, well-defined arm spines. Disk plates thick, separated by narrow grooves, and arranged above like steps. Side arm plates flaring a little outward, . . .	*Ophiomusium scalare.*
	Two or three minute arm spines. Disk plates coarse, swollen, and irregular. Two or three marginal plates besides the central one in the lower interbrachial space, . . .	*Ophiomusium testudo.*
	Five short, sharp, well-marked arm spines. The great lower interbrachial plate is separated by a square one from the mouth shield. Margin of disk set with small points, . .	*Ophiomusium granosum.*
Basal side arm plates very flat and wide, encroaching much on the interbrachial space, and bearing stout spines on their outer edge. First under arm plate similar to those beyond, and furnished with a tentacle scale, ...	Genital scales meeting on median line of lower interbrachial space.	*Ophiomusium pulchellum.*
	First side arm plates meeting in median line of lower interbrachial space, ...	*Ophiomusium flabellum.*

Ophiomusium serratum, Lym. (Pl. II. figs. 1–3; Pl. XXXIX. fig. 10).

Ophiomusium serratum, Lym., Bull. Mus. Comp. Zool., vol. v., part 7, p. 109, pl. i. figs. 23–25; also part 9, p. 220, 1878.

Arms rather slender and tapering, cylindrical or but slightly wavy. Upper and

under arm plates persisting nearly to end of arm, but no tentacles beyond third or fourth under plate. Genital opening bounded by small close-set papillæ. Interbrachial space between radial shields occupied by two large plates. Papillæ along genital openings extending upward as a small arm comb. Four or five small arm spines.

(Type specimen from Station 23.) Diameter of disk 10 mm. Width of arm near disk, without spines, 2·5 mm. Mouth papillæ six on each side, with one at angle of jaw, all in close contact. Mouth shields heart or rounded diamond shape, with an angle inward; length to breadth 1·5 : 1. Side mouth shields long triangular, extending farther out than the mouth shield; wider without than within, where they just meet. The first four under arm plates bearing tentacle scales are pentagonal, with an obtuse angle inward, outer edge slightly curved, lateral sides re-enteringly curved; length to breadth, second arm plate, ·1 : ·7. Side arm plates thick, constricted within, meeting below, even within the disk, and above, beyond the second upper arm plate; those beyond are also pentagonal, but small, broad, and widely separated. Upper arm plates triangular, with an acute angle inward, and outer edge curved; length to breadth 1 : ·7. Disk covered with flat plates closely soldered; in the central space within the radial shields are six rounded primary plates, separated by a circular row of small ones; the interbrachial space is occupied by two angular plates, the outer one much larger. Radial shields long triangular, separated their entire length by one small and two large scales. In the interbrachial space below are two large circular plates, extending from the mouth shield to margin of disk, on either side of which are smaller circular scales. Genital scales long and very narrow, extending from the edge of the mouth shield to margin of disk, on the free edge of which are fine tooth-like papillæ, corresponding to similar papillæ along the side mouth shields, giving a resemblance to *Ophioglypha*. At the base of the arm above are short, blunt papillæ on either side of first upper arm plate. Arm spines four or five, delicate, pointed, nearly equally placed; middle one longest and nearly half as long as a side arm plate. A single circular tentacle scale on second, third, and fourth under arm plates, situated near the inner angle. The entire surface of the animal is microscopically tuberculated. Colour in alcohol, white.

This species much resembles *Ophiomusium eburneum*, but I am unable to decide that they are the same.

Station 23.—March 15, 1873; off Sombrero Island; 450 fathoms; globigerina ooze.

Ophiomusium armigerum, Lym. (Pl. II. figs. 7–9).

Ophiomusium armigerum, Lym., Bull. Mus. Comp. Zool., vol. v., part 7, p. 109, pl. i. figs. 21, 22, 1878.

Arms rather slender and tapering, cylindrical or but slightly wavy. Upper and under arm plates persisting nearly to end of arm, but no tentacles beyond third or fourth

under plate. Genital opening bounded by small close-set papillæ, which extend upward as a small arm comb. Side mouth shields small and short. Upper arm plates comparatively large, some of the basal ones inclining to hexagonal. Three or four small arm spines.

(Type specimen from Station 332.)' Diameter of disk 11 mm. Length of arm 47 mm. Width of arm near the disk 2·5 mm. Mouth papillæ six on each side, forming a close line, and one larger one at apex of jaw. Mouth frames long triangular, quite large. Mouth shields rounded triangular, with an angle inward; length to breadth 1·5 : 1·5. Side mouth shields short triangular, touching by their narrow ends within. First under arm plate circular, very small; the next three are furnished with tentacle scales, and are three-sided, with an angle inward, and outer side curved; the others are smaller and roughly triangular, with an angle inward, and lateral sides curved. Side arm plates thick, and meeting broadly below beyond the disk, but just touching above on the basal joints. Upper arm plates long, diamond shaped, except at base of arm, where the outer and inner angles are truncated. Genital scales very narrow, and so closely soldered to surrounding parts as to be hardly distinguishable. Near inner end of genital opening they bear a few square close-set papillæ, as in *Ophioglypha*. Interbrachial space below covered by ten or a dozen circular plates of irregular outline. Upper surface of disk covered by long, rudely triangular, somewhat sunken radial shields, widely separated their entire length by two or three large and several minute rounded plates; the interbrachial space covered by a large circular marginal plate, with various smaller ones within; the central space within the radial shields by six rounded, sunken primary plates, separated by about three rows of small scales. The entire surface is microscopically tuberculous. Three or four small cylindrical arm spines, situated well up on the outer edge of the side arm plate; they stand out from the arm, and the two middle ones are largest. The second, third, and fourth under arm plates have, near their inner end, small oval tentacle scales, one to each pore. Colour in alcohol, white.

Station 83.—July 15, 1873; lat. 33° 13′ N., long. 18° 13′ W.; 1650 fathoms; globigerina ooze. Station 106.—August 25, 1873; lat. 1° 47′ N., long. 24° 26′ W.; 1850 fathoms; globigerina ooze. Station 299.—December 14, 1875; lat. 33° 31′ S., long. 74° 43′ W.; 2160 fathoms (same species?); grey mud. Station 332.—March 10, 1876; lat. 37° 29′ S., long. 27° 31′ W.; 2200 fathoms; globigerina ooze.

Ophiomusium corticosum, Lym. (Pl. II. figs. 13–15).

> *Ophiomusium corticosum*, Lym., Bull. Mus. Comp. Zool., vol. v., part 7, p. 110, pl. i. figs. 19, 20, 1878.

Arms rather slender and tapering, cylindrical, or but slightly wavy. Upper and under arm plates persisting nearly to end of arm, but no tentacles beyond third or

fourth under plate. Genital opening bounded by small close-set papillæ. Disk thick. Side mouth shields and under arm plates much swollen. Outer mouth papillæ much larger than inner. Genital papillæ large and bead-like. Six or seven small arm spines.

(Type specimen from Station 224.) Diameter of disk 12 mm. Width of arm, without spines, close to disk 2 mm. Mouth papillæ seven on each side, three basal ones considerably largest; all forming a close line. Mouth shields small, triangular, with acute angle inward, and outer edge much rounded. Side mouth shields large, much longer than broad, wider without, meeting within; length to breadth 1·7 : 1. Under arm plates from the second to the fourth or fifth furnished with tentacles; they are axe-shaped, with an angle inward, lateral sides re-enteringly curved, and outer side curved; beyond, the plates are rudimentary and diamond-shaped. Side arm plates thick, meeting above and below beyond the disk. Upper arm plates diamond-shaped, with an angle without and within; length to breadth ·7 : ·7. Genital scales long and narrow, bearing a row of papillæ on the free edge. Lower interbrachial space covered by thin curved plates, of which five form a transverse row along the disk margin; upper surface of disk pentagonal. Radial shields triangular, separated their entire length by a row of small plates, and there is a similar row in each interbrachial space; the central space within the radial shields is covered by six circular primary plates, separated by small ones. Arm spines six or seven in number, very short and blunt, situated on the outer edge of the side arm plate. No scales beyond the fourth or fifth under arm plate; they are large, oval, and situated near the inner angle of the plate, one to each pore. Colour in alcohol, grey.

Station 224.—March 21, 1875; lat. 7° 45′ N., long. 144° 20′ E.; 1850 fathoms; globigerina ooze.

Ophiomusium cancellatum, Lym. (Pl. II. figs. 16–18).

Ophiomusium cancellatum, Lym., Bull. Mus. Comp. Zool., vol. v., part 7, p. 111, pl. i. figs. 17, 18, 1878.

Arms rather slender and tapering, cylindrical, or but slightly wavy. Upper and under arm plates persisting nearly to end of arm, but no tentacles beyond third or fourth under plate. Genital openings bounded by small close-set papillæ. Disk flat, covered with small imbricated scales, which are nearly equal, except the marginal, which are larger. Upper arm plates large; the basal ones long hexagonal.

(Type specimen from Station 236.) Diameter of disk 8·5 mm. Width of arm, without spines, 1·5 mm. Length of arm 28 mm. Mouth papillæ forming a close line, six on each side, with one, diamond-shaped, at angle of jaw. Mouth shields triangular, with an angle inward, sides equal and curved; length to breadth 1 : 1. Side mouth

shields long, triangular; much wider without than within, where they do not quite meet. Genital scales concealed under fine, closely-set disk scales. Under arm plates pentagonal near base of arm, farther out quadrangular, with an angle inward; one tentacle scale which is round, and situated on inner angle of the second and third under arm plates. Side arm plates thick, minutely tuberculous, meeting below, but not above, near base of arm. Upper arm plates near base of arm hexagonal, with outer and inner sides very short. Disk covered above and below by thin, rounded, minutely tuberculous scales; on the margin are larger angular plates of the same character. Radial shields small, minutely tuberculous, rounded triangular; length to breadth 1·5 : ·7; widely separated by a group of half a dozen plates, of which the outer ones are much wider than long. Two or three minute peg-like arm spines situated in a notch low on the side arm plate. Colour in alcohol, pale grey.

Station 33.—April 4, 1873; off Bermudas; 435 fathoms (same species ?); mud. Station 236.—June 5, 1875; lat. 34° 58′ N., long. 139° 30′ E.; 420 to 775 fathoms; mud.

Ophiomusium archaster, Wyv. Thom. (Pl. II. figs. 4–6).

Ophiomusium archaster, Wyv. Thom., MS.; Lym., Bull. Mus. Comp. Zool., vol. v., part 7, p. 112, pl. ii. figs. 28, 29, 32, 1878.

Arms rather slender and tapering, cylindrical, or but slightly wavy. Upper and under arm plates persisting nearly to end of arm, but no tentacles beyond third or fourth under plate. Genital opening bounded by small close-set papillæ. Disk covered by thick skin, its upper surface occupied chiefly (and in half-grown specimens almost entirely) by radial shields and large primary plates, with small scales between. Arms even and cylindrical. Four minute rudimentary arm spines.

(Type specimen from Station 323.) Diameter of disk 10 mm. Width of arm close to disk, without spines, 2·5 mm. Five mouth papillæ on each side, short, pointed, closely joined with one large, diamond-shape at angle of jaw. Mouth shields broad, heart-shaped, with a peak within; length to breadth 1·3 : 1·5. Side mouth shields long triangular, very broad without; tapering and curved inward where they meet. First under arm plate very small, triangular, with angle inward; the three next bear tentacle scales, and are three-sided, with lateral sides a little re-enteringly curved, and outer side slightly curved; the rest are small, triangular, with outer side curved. Side arm plates thick, slightly swollen, somewhat constricted within, meeting below throughout, and above beyond the third upper arm plate. First two upper arm plates rounded and much wider than those beyond, which are triangular, with an angle inward, lateral sides straight, outer edge much curved. Disk flat, covered with thick, minutely tuberculous plates and scales. Radial shields

sunken, of irregular rhomboidal shape, with corners rounded; length to breadth 1·7 : 1·3. Central primary plate smaller than the others, circular, sunken, separated by a double row of small circular scales from five large sunken, nearly round plates which surround it; the rest of the upper surface is covered with small rounded scales, with a larger one on the margin. Under surface covered with small rounded plates, irregularly disposed; genital scales long and very narrow, on the free edge of which are fine, short, square papillæ, corresponding to similar ones on the side arm plates. One small rounded tentacle scale, situated near inner angle of plate. Three or four minute, slender, rounded arm spines standing low down on arm plate; upper one longest. Colour in alcohol, straw.

Station 323.—February 28, 1876; lat. 35° 39′ S., long. 50° 47′ W.; 1900 fathoms; grey mud.

Ophiomusium lymani, Wyv. Thom.

Ophiomusium Lymani, Wyv. Thom., Depths of the Sea, p. 172, figs. 32, 33, 1873; Lym., Bull. Mus. Comp. Zool., vol. v., part 7, p. 113.

The specimens from the following widely separated stations showed certain minor differences. For example, those from Station 235 had more arm spines and rather more numerous lower disk plates, and the tentacle scales were entire, instead of divided. I have deemed it best to keep the varieties together for the present.

Station 45.—May 3, 1873; lat. 38° 34′ N., long. 72° 10′ W.; 1240 fathoms; mud. Station 50.—May 21, 1873; lat. 42° 8′ N., long. 63° 39′ W.; 1250 fathoms; grey ooze. Station 76.—July 3, 1873; lat. 38° 11′ N., long. 27° 9′ W.; 900 fathoms; globigerina ooze. Off Tristan d'Acunha; 1100 fathoms. Station 169.—July 10, 1874; lat. 37° 34′ S., long. 179° 22′ E.; 700 fathoms; grey ooze. Station 191.—September 23, 1874; lat. 5° 41′ S., long. 134° 4′ E.; 800 fathoms; mud. Station 235.—June 4, 1875; lat. 34° 7′ N., long. 138° 0′ E.; 565 fathoms; mud. Station 296.—November 9, 1875; lat. 38° 6′ S., long. 88° 2′ W.; 1825 fathoms (only arms); red clay.

Ophiomusium laqueatum, Lym. (Pl. II. figs. 10–12).

Ophiomusium laqueatum, Lym., Bull. Mus. Comp. Zool., vol. v., part 7, p. 113, pl. i. 14–16, 1878.

Upper disk covered by large swollen radial shields, with minute imbricated scaling in centre, arms wide and thick, with side arm plates much swollen and rounded. Upper arm plates broad, diamond-shape.

(Type specimen from Station 192.) Diameter of disk 14 mm. Width of arm 3·5 mm. Mouth papillæ six or seven on each side, and one, diamond-shaped, at angle of jaw. Mouth shields ovoid, slightly pointed within; length to breadth 2 : 1·3. Side mouth shields long, narrow, having curved sides, wider without than within, where they nearly or quite meet; length 2·3 mm. Genital scales very long and narrow, extending from mouth shield to margin of disk, and bearing on their free edge an irregular row of close-set oblong papillæ. Under arm plates triangular, with an angle inward; in the first two plates the angle is blunt, becoming more acute in those beyond; outer edge somewhat curved. Tentacle scales only on the first three plates; they are minute, circular, two in number, set close together and situated very near the inner angle. Side arm plates thick, swollen, barely meeting above and below at the inner angle of the upper and under arm plates. Upper arm plates near base of arm quadrangular, wider than long; length to breadth 1·3 : 2; towards end of arm they are three-sided. Disk covered in centre with fine delicate scales, among which appear six larger rounded primary plates, which are widely separated, one in the centre, and one in each brachial space. Radial shields oval, swollen, a little wider without than within, separated from each other throughout their entire length by two or three long oval scales mingled with finer. Interbrachial spaces on upper surface occupied by two or three rounded scales, bordered by smaller, of which the largest is on the margin of disk. Under interbrachial space covered by about a dozen thick, rounded, swollen scales, almost concealing the genital scale; the three largest stand on or near the margin. Four minute peg-shaped arm spines; three standing together, low on the edge of the plate; the fourth placed much above them. Colour in alcohol, white.

Station 192.—September 26, 1874; lat. 5° 42′ S., long. 132° 25′ E.; 129 fathoms; mud.

Ophiomusium lütkeni, Lym. (Pl. I. figs. 16–18).

Ophiomusium Lütkeni., Lym., Bull. Mus. Comp. Zool., vol. v., part 7, p. 114, pl. v. figs. 138–140, 1878.

Disk covered by large, angular, smooth, swollen plates, of which the interbrachial marginal is largest. Arms wide and thick, with side arm plates much swollen and rounded, and bearing a spine on their upper surface.

(Type specimen from Station 192.) Diameter of disk 13 mm. Length of arm about 45 mm. Width of arm close to disk, without spines, 2·5 mm. Four or five large square mouth papillæ on each side, with one, small and slender, at apex of jaw, all closely joined, those without being deeper than those within. Mouth shields rudely three-sided, having a blunt angle within and a curved outer edge broken by angles. Length to breadth 2·5 : 2·7. Side mouth shields longer than

broad, and thick, meeting well within, where they are slightly narrower than without. First under arm plate small, nearly square, with all four angles rounded; the next two larger, pentagonal, with an angle inward, outer lateral corners rounded, and deep re-entering curves on the lateral sides, where the tentacle scales stand; the under arm plates beyond these are minute and triangular, having an angle inward and the outer edge slightly curved. Side arm plates large, swelling without into a rounded ridge and forming the greater part of the covering of the arm. Upper arm plates triangular, with an angle inward, and all three sides slightly curved. Disk massive and flat, covered with thick, slightly swollen plates, one pentagonal primary in the centre, surrounded by five rudely hexagonal plates; interbrachial spaces filled by one hexagonal plate within, and a smaller quadrangular extending to the very large marginal plate, which is much swollen and has a constriction on the outer edge. Radial shields large and angular, wider without than within, with outer angles rounded, separated their entire length within by an hour-glass shaped wedge of three small plates. Lower interbrachial space covered by the great marginal plate, the broad genital scales extending from the mouth shield to the marginal plate, and by three intermediate plates. There are two short blunt arm spines, besides a supplementary spine on the top of the side arm plate. Tentacle pores at the second and third under arm plates only, with one small round scale on each pore. Colour in alcohol, greyish.

By its general shape, and by the extra spines on top of the arm, this species approaches *Ophiomusium acuferum*, but is distinguished by form and arrangement of disk plates. It is covered by a well-marked skin, to which often adhere numerous Globigerinæ. The supplementary arm spines do not go beyond the third joint from the disk and are often missing.

Station 192.—September 26, 1874; lat. 5° 42′ S., long. 132° 25′ E.; 129 fathoms; mud.

Ophiomusium validum, Ljn. (Pl. I. figs. 1–3; Pl. XXXIX. figs. 11–13).

> *Ophiomusium validum*, Ljn., Dr. Goës, Oph. Öf. Kong. Akad., p. 618, 1871; Bull. Mus. Zool., vol. v., part 7, p. 114, pl. i. figs. 7–9; Bull. Mus. Comp. Zool., vol. v., part 9, p. 219.

Most of the lower interbrachial space outside the mouth shield is occupied by broad genital scales and a great central plate. No under arm plates beyond the third. Four small, equally spaced arm spines. Smaller upper arm plates. The great lower interbrachial plate has usually two much smaller at its outer corners.

(Type specimen from Station 24.) Diameter of disk 8·5 mm. Width of arm, without spines, close to disk 2 mm. Mouth papillæ five on each side, with a large diamond-shaped one at angle of jaw, all forming a close line. Mouth shields large, irregularly

pentagonal, with an acute angle inward and outer edge straight; length to breadth 2 : 1·7. Side mouth shields longer than broad, wider without than within; outer ends curved, touching by their narrow ends within. Genital scales large, semicircular, stretching from mouth shield to margin of disk. There are only three under arm plates, the first small and diamond-shaped, lying at outer end of mouth slit; second and third pentagonal, with an angle inward, and lateral and outer sides nearly straight. Side arm plates thick, slightly swollen, and beyond the third under arm plate forming the entire covering of the arm, with the exception of rudimentary triangular upper arm plates, which do not extend to the tip of the arm. Disk rather flat, and covered by closely soldered plates; the upper surface is occupied by six primary plates, separated by many smaller ones; radial shields rounded triangular, with acute angle within; outer edges curved, strongly diverging inward, and separated by a triangular scale. In interbrachial space are two angular plates, the outer one wide quadrangular and closely soldered to a great marginal plate, which, with the genital scales, covers the interbrachial space on the under surface of the disk. At base of arm above are four little plates, two central and two lateral. Four short, blunt, and thick arm spines, situated low on the outer edge of the side arm plate. Tentacle scales minute, rounded, situated on the inner angle of second and third under arm plates. Colour in alcohol, pale grey.

In presence of the many new species of *Ophiomusium*, it has been thought well to give figures and a full description of this one.

Station 24.—March 25, 1873; off Culebra Island; 390 fathoms; mud. Station 23.—March 15, 1873; close to Sombrero Island; 450 fathoms; globigerina ooze.

Ophiomusium simplex, Lym. (Pl. I. figs. 7–9).

Ophiomusium simplex, Lym., Bull. Mus. Comp. Zool., vol. v., part 7, p. 115, pl. i. figs. 10, 11, 1878.

Most of the lower interbrachial space outside the mouth shield is occupied by broad genital scales and a great central plate. No under arm plates beyond the third. Two minute arm spines set low down. Besides the great interbrachial plate below there are three others along the margin.

(Type specimen from Amboyna.) Diameter of disk 6 mm. Width of arm without spines 1·5 mm.; length of arm 15 mm. Mouth papillæ seven on each side, and one, spear-head shaped, at angle of jaw, closely soldered together and forming a slightly raised continuous line. Mouth shields little longer than broad, pentagonal, with acute angle within, at the corners of which begin the genital openings; outer side straight. Side mouth shields short, wide, with curved sides meeting within; length 1 mm. Genital scales large, semicircular, somewhat swollen, running from lateral corners of mouth shield to margin of disk. There are only two under arm plates besides the small semicircular

one at the angle of the mouth slit; they are pentagonal, with an angle inward; lateral and inner lateral sides straight; outer side slightly curved. Tentacle scales on second and third plates small, circular, and situated at the inner corners. Side arm plates swollen, forming the entire covering of the arm beyond the last under arm plate, with the exception of minute upper arm plates, which are triangular, with an angle within. Disk covered with closely soldered plates; in the centre of the upper surface is a pentagonal plate, surrounded by five rudely hexagonal, which are connected with the radial shields by plates somewhat longer than broad, between each pair of which are large angular scales Radial shields shaped like a rounded pear seed, much swollen, touching at their middle point, but diverging outward and inward, separated on either side of the point of contact by a small triangular scale; on the interbrachial disk margin is an angular, much swollen plate, joining three of similar character, which, with the genital scales, cover the under surface of the interbrachial space; at the base of the arm above are three small rounded scales. Arm spines two, minute, blunt, and set low down on the edge of the side arm plate. Colour in alcohol, white.

Amboyna; 100 fathoms.

Ophiomusium lunare, Lym. (Pl. I. figs. 13–16).

Ophiomusium lunare, Lym., Bull. Mus. Comp. Zool., vol. v., part 7, p. 116, pl. i. figs. 4–6, 1878.

Most of the lower interbrachial space outside the mouth shield is occupied by broad genital scales and a great central plate. No under arm plates beyond the third. Two minute arm spines set back from edge of side arm plate. Only one lower interbrachial plate. No upper arm plates beyond second.

(Type specimen from Station 219.) Diameter of disk 7 mm. Width of arm, without spines, close to disk 1·5 mm. Length of arm about 20 mm. Mouth papillæ seven on each side, with one, somewhat larger than the rest, at the angle of the jaw. Mouth shields large, pentagonal, with an acute angle within, and outer side straight; length to breadth 1·5 : 1. Side mouth shields large, long triangular; sides slightly curved, with narrow ends touching within. Genital scales long, with interbrachial side curved, starting at the inner corner of the genital opening and touching the radial shields with their outer ends. Under arm plates pentagonal, with an angle inward, and outer side slightly curved; there are only two besides the small one at the outer end of mouth slit. Side arm plates thick, composing the entire covering of the arm, with the exception of the minute triangular upper arm plate, which has an angle inward, and outer side curved, and disappears on the second or third joint. The disk is rather flat, covered with microscopically tuberculated plates, well soldered together; the margin is occupied by one large plate, touching the radial shields on either side, and extending below to the mouth shields; the centre is

occupied by six primary plates, one pentagonal, surrounded by five rudely hexagonal. The radial shields are pear-seed shape, and large, having a blunt angle inward, and outer edge much rounded; they touch only at their middle point, and are separated within and without by a small triangular scale. The interbrachial space below is covered by the large marginal plate, already mentioned, and the stout genital scales. Tentacle scales minute, circular, situated at the inner corners of the second and third plates. Two very small, short, and blunt arm spines. Colour in alcohol, white.

Station 219.—March 10, 1875; lat. 1° 50′ S., long. 146° 42′ E.; 150 fathoms; mud.

Ophiomusium scalare, Lym. (Pl. I. figs. 4–6).

Ophiomusium scalare, Lym., Bull. Mus. Comp. Zool., vol. v., part 7, p. 117, pl. i. figs. 1–3, 1878.

Most of the lower interbrachial space, outside the mouth shield, is occupied by broad genital scales and a great central plate. No under arm plates beyond the third. Three short, stout, well-defined arm spines. Disk plates thick, separated by narrow grooves, and arranged above like steps. Side arm plates flaring a little outward.

(Type specimen from Station 171.) Diameter of disk 5 mm. Width of arm without spines 1 mm. Length of arm about 10 mm. Mouth papillæ three on each side, and one at angle of jaw, closely soldered together, forming high continuous ridges, radiating from the mouth. Mouth shields five sided, having a long acute angle within, and the outer side straight; length to breadth 1 : 1. Side mouth shields long, narrow, meeting within; broader without than within, where they join the first side arm plate; length 1 mm. Genital scales large semicircular, somewhat swollen. Under arm plates minute, three in number; the first one semicircular, wedged between the side mouth shields; second and third longer than wide, with acute angle inward, lateral sides straight, and outer side slightly curved. Tentacle scales round, very small, situated near inner angle of the under arm plate. Side arm plates thick, swollen, covering almost the entire arm beyond the disk. Upper arm plates minute, diamond-shaped. Under surface of disk covered, in the interbrachial spaces, by genital scales, and three large swollen semicircular plates, whose outer edge is curved; upper surface of disk covered with small tuberculous plates, forming a much raised rosette, the central plate of which is pentagonal, the primary plates surrounding it semicircular. Radial shields closely soldered together, and partly separated by an angular plate. In the interbrachial spaces are two large plates, radiating from the central rosette, one five sided, with an acute angle inward, and joined to the inner edge of the radial shields; the other, which is on the margin of the disk, is a large, nearly square, corrugated plate, and is attached on either side to small oval plates, which form above the base of the arm two irregular transverse rows, three

or four in each row. Three small peg-like arm spines about one-third as long as a joint. Colour in alcohol, pale grey.

I was unable to detect any genital openings.

Station 171.—July 15, 1874; lat. 28° 33′ S., long. 177° 50′ W.; 600 fathoms.

Ophiomusium granosum, Lym. (Pl. I. figs. 10–12).

Ophiomusium granosum, Lym., Bull. Mus. Comp. Zool., vol. v., part 7, p. 118, pl. i. figs. 12, 13, 1878.

Most of the lower interbrachial space outside the mouth shield is occupied by broad genital scales and a great central plate. No under arm plates beyond the third. Five short, sharp, well-marked arm spines. The great lower interbrachial plate is separated by a square one from the mouth shield. Margin of disk set with small points.

(Type specimen from Station 237.) Diameter of disk 10 mm. Width of arm, without spines, close to disk 2 mm. Mouth papillæ very closely soldered together, forming a ridge. Mouth shields triangular, with an acute angle within, and the outer edge curved. They bear minute spines. Side mouth shields long and narrow; meeting within, where they are narrowest. Genital scales large, angular, longer than wide. First under arm plate semicircular; second and third triangular, with an acute angle inward. Side arm plates minutely tuberculous, meeting broadly above and below, and nearly covering the entire arm beyond the disk. Upper arm plates minute, triangular, with acute angle inward. There are no tentacle scales. Disk covered with closely soldered plates, having decided furrows between them; the microscopic tuberculation usual in the genus is very coarse, and rises near edge of disk into small points. The margin is occupied by a large, angular, swollen plate, covered with points, which connects the radial shields with the genital scales, and is united to the mouth shield by a smaller rectangular plate, also carrying points. Radial shields pear-seed shape, diverging inward, where they are separated by a triangular plate. In centre of upper surface of disk is a large pentagonal primary plate, surrounded by five others, quadrangular, and connected with the radial shields by five rudely-triangular pieces; in each interbrachial space above are two quadrangular plates, besides that of the margin. Arm spines five in number, occupying the whole edge of the side arm plates; they are short, rounded, and delicately tapering. Colour in alcohol, grey.

Station 237.—June 17, 1875; lat. 34° 37′ N., long. 140° 32′ E.; 1875 fathoms; mud.

Ophiomusium pulchellum, Wyv. Thom. (Pl. III. figs. 1–3).

Ophiomusium pulchellum, Wyv. Thom., Voy. "Chall.," Atlantic, vol. ii. p. 67, figs. 18, 19. Lym., Bull. Mus. Comp. Zool., vol. v., part 7, p. 118, pl. v. figs. 144, 145.

Primary plates bearing a large central tubercle; second pair of side arm plates wide,

and flaring below; lower interbrachial space occupied almost wholly by large genital scales, and a marginal plate like a tubercle.

(Type specimen from Station 122.) Diameter of disk 4·5 mm. Length of arm about 7 mm. Width of arm close to disk, without spines, 1 mm. Mouth papillæ closely soldered, forming a straight line on the sides, with one round, bluntly pointed papillæ at apex of the jaw. Mouth shields small, triangular, with a long angle within, outer edge much rounded; length to breadth ·5 : ·5. Side mouth shields large, long, and narrow, meeting within, wider without than within, with outer ends rounded. First under arm plate of a rude wedge shape, having the outer edge widest, and curved, long lateral sides slightly re-enteringly curved, and a short blunt angle within; second, third, and fourth plates broader than long, much broader without than within, lateral sides with deep re-entering curve, and outer side strongly curved; fifth plate triangular, and much smaller; beyond which the plates are diamond-shape and minute. Side arm plates wide and swollen, meeting broadly above and below; beyond the sixth under arm plate forming almost the entire covering of arm; the second pair are very wide below, flattened and flaring, and form a part of the disk margin. Upper arm plates small, broader than long, with outer edge gently and inner edge deeply curved; growing rapidly smaller, and almost disappearing beyond the sixth. Disk thick and round, covered with swollen, microscopically tuberculous plates; in the centre are six primary plates, forming a regular rosette, the central one pentagonal, the others hexagonal, and each bearing a large tubercle; in the interbrachial space there is one large square plate, also bearing a tubercle; outside this is a large, much swollen marginal plate, which is much wider without than within, the inner edge being straight and the outer re-enteringly curved. Radial shields large, rudely oval, longer than broad, joined for nearly their whole length; overlapped on their inner ends by one of the primary plates, and separated without by a small, much swollen, semicircular plate; length to breadth 1 : ·7. On the lower interbrachial space there are two minute plates, just outside the mouth shield; then the two great genital scales, which occupy most of the space, and meet within at the mouth shield, and are separated without by a large thick plate, wedged between them, which extends outward beyond the margin, in form of a tubercle. The first side arm plate carries two short, thick, blunt arm spines; the second, which forms part of the margin of the disk, has three spines; the rest have two, all situated low on the outer edge. One large, rounded tentacle scale on the inner side of each tentacle pore of the first five under arm plates. Colour in alcohol, white.

By its curious, flaring under arm plates at the base of the arm, and its short, rapidly tapering arm, this species gets a fanciful resemblance to some of the star-fishes. It is an aberrant species, yet is correctly included by Sir Wyville Thomson under *Ophiomusium*. Its distribution is wide, and embraces the South Atlantic, including the Cape of Good Hope; and in depth from 150 to 1675 fathoms.

The description is from a specimen larger than the one figured.

Station 87.—July 21, 1873; lat. 25° 49′ N., long. 20° 12′ W.; 1675 fathoms (Wyv. Thom.). Station 122.—September 10, 1873; lat. 9° 10′ S., long. 34° 53′ W.; 350 fathoms; mud. Station 142.—December 18, 1873; lat. 35° 4′ S., long. 18° 37′ E.; 150 fathoms; sand.

Ophiomusium flabellum, Lym. (Pl. III. figs. 4–6).

Ophiomusium flabellum, Lym., Bull. Mus. Comp. Zool., vol. v., part 7, p. 120, pl. v. figs. 141–143, 1878.

Basal side arm plates very flat and wide, encroaching much on the interbrachial space, and bearing stout spines on their outer edge. First under arm plate similar to those beyond, and furnished with a tentacle scale. First side arm plates meeting on median line of lower interbrachial space.

Diameter of disk 3·3 mm. Length of arm 3·3 mm. Width of arm close to disk, without spines, 1 mm. Mouth papillæ closely soldered together, forming a continuous line. Large triangular mouth frames. Mouth shields minute, diamond-shape. Side mouth shields very large, meeting broadly within, with outer ends wide and much rounded, having a re-entering curve on the lateral edge, where stands the tentacle scale. First, second, and third under arm plates pentagonal, with a blunt angle within, outer edge slightly curved, and lateral sides re-enteringly curved; the second is largest of the three; the fourth and last is a minute, broad, triangular scale, without a tentacle pore. The first pair of side arm plates are swollen, and of such extraordinary size as to meet on the median line of the interbrachial space; the second are smaller, and meet above and below; beyond the fourth under arm plate they form the entire covering of the arm. Only two minute triangular upper arm plates, having the outer edge slightly curved. Disk high and round, covered with thick, much swollen plates, whereof the middle are somewhat sunken; the central primary is pentagonal, surrounded by a row of angular plates, of nearly equal size; outside this row, in each interbrachial space, is another angular plate separating the inner ends of the rather long, closely joined radial shields. On the interbrachial margin is a large, much swollen boss, rising high above the other disk plates, and connecting the neighbouring radial shields. On the interbrachial space of the under surface there is but one minute triangular scale, outside the enormous first pair of side arm plates; these carry on their outer edge three small blunt spines, which look like marginal disk papillæ; the next pair carry only two spines; and beyond, there is only one, which is blunt and short, and carried low on the outer edge of the plate. Only three pairs of tentacle pores (including the mouth tentacles), each with one large rounded scale on the lateral sides of the under arm plates. Colour in alcohol, very pale brown.

This species and *Ophiomusium pulchellum*, by their large flat side arm plates of the first pair, and peculiar first under arm plate, which bears tentacle scales, are strongly distinguished from others of the same genus.

Off Port Jackson ; 30 to 35 fathoms.

Species of *Ophiomusium* not herein described.

Ophiomusium eburneum, Lym., Bull. Mus. Comp. Zool., vol. i., part 10, p. 322, 1869 ; Ill. Cat. Mus. Comp. Zool., No. vi., pl. ii. figs. 1–3 ; Bull. Mus. Comp. Zool., vol. v., part 9, p. 220.

West Indies ; 230 to 325 fathoms.

Ophiomusium testudo, Lym., Ill. Cat. Mus. Comp. Zool., No. viii. part 2, p. 8, pl. i. figs. 6–8, 1875 ; Bull. Mus. Comp. Zool., vol. v., part 9, p. 219.

West Indies ; 100 to 177 fathoms.

Ophiomusium planum, Lym., Bull. Mus. Comp. Zool., vol. v., part 9, p. 218, pl. iii. figs. 46–48.

West Indies ; 955 fathoms.

Ophiomusium acuferum, Lym., Ill. Cat. Mus. Comp. Zool., No. viii. part 2, p. 7, pl. i. figs. 1–5, 1875 ; Bull. Mus. Comp, Zool., vol. v., part 9, p. 219.

West Indies ; 42 to 220 fathoms.

Ophiolipus.

Ophiolipus, Lym., Bull. Mus. Comp. Zool., vol. v., part 9, 1878.

Entire animal covered with a thick, smooth skin, which more or less obscures the underlying plates. Mouth papillæ. Teeth. No tooth papillæ. Tentacle pores only at the basal under arm plates, beyond these there are none. Upper arm plates rudimentary and scarcely calcified. Two genital openings in each interbrachial space.

Despite its thick, uncalcified skin, this genus stands very near *Ophiomusium*, from which, however, it is further separated by the rudimentary upper arm plates, which consist only of thin, disconnected, irregular fragments.

Although apparently soft and naked, the disk skin, examined from the under side, is found to be supported by very large oval radial shields, and by more or less crusty scales and plates. The genital plates have a rounded shaft and a large clubbed head, to which is attached a rather thin and long genital scale which shares in the articulation with the

radial shield. Although proportionately smaller than in *Ophiomusium*, the jaws have a similar general form, but are furnished with small, stout peristomial plates divided in two parts. The first three arm bones are discoid, with wings which have marginal grooves, somewhat as in *Ophiolepis;* those beyond, however, grow longer and longer, with flaring projections and a wide longitudinal canal above. Towards the end of the arm they are still more flaring, with two great lobes covering the places where the tentacles usually are.

Species of *Ophiolipus* not herein described.

Ophiolipus agassizii, Lym. (Pl. XXXIX. figs. 1–3).

Ophiolipus Agassizii, Lym., Bull. Mus. Comp. Zool., vol. v., part 9, p. 220, pl. iii. figs. 52–54, 1878.

Gulf of Mexico; 118 fathoms.

Ophiomastus.

Ophiomastus, Lym., Bull. Mus. Comp. Zool., vol. v., part 7, 1878.

Disk arched and extremely high, covered with a few large thick plates, among which the primaries are conspicuous for superior size. Arms short, with large thick side arm plates. First under arm plate similar to and nearly as large as those beyond. Mouth papillæ arranged in a narrow close-set line; teeth rather slender; no tooth papillæ. Small smooth arm spines arranged along outer edge of side arm plates. Two narrow genital openings in each interbrachial space.

Almost the whole roof of the disk is composed of primary plates, which are of a granular structure and much larger than the subordinate radial shields. The low, flaring jaws and mouth frames are furnished with a single, small, crusty peristomial plate. The massive arm plates enclose small, long, cylindrical arm bones, of rudimentary structure, and have a well-marked longitudinal canal on the upper surface. The genital plate is short, wide, and stout, with a spatula-like end, and has a scale of a similar form.

See Plate XXXIX. fig. 14.

Ophiomastus tegulitius, Lym. (Pl. VIII. figs. 16–18).

Ophiomastus tegulitius, Lym., Bull. Mus. Comp. Zool., vol. v., part 7, p. 104, pl. vi. figs. 167–169, 1878.

Two very short, stout arm spines. Disk plates swollen and microscopically tuberculous. Side mouth shield of a pointed ovoid shape.

(Type specimen from Station 165.) Diameter of disk 4 mm. Length of arm about 6 mm. Width of arm close to disk, without spines, 1 mm. Mouth papillæ so closely soldered as to form an almost continuous narrow line from side mouth shields to apex; on either side is a long curved one, followed by two shorter, and by a narrow spine-like one at apex of angle. Mouth shield pentagonal, with an angle inward, longer than wide; inner lateral sides straight, outer lateral corners rounded; length to breadth ·7 : ·5. Side mouth shields large, swollen; broadest and rounded within, where they meet, then tapering outward along the inner lateral sides of the mouth shields. Under arm plates long pentagonal, with an angle inward, lateral sides re-enteringly curved, outer side slightly curved. Side arm plates large, thick, and swollen, meeting below and above; upper arm plates small; first one diamond-shaped, and second triangular with sharp angle inward and outer edge straight; the rest are similar, but grow rapidly smaller. Disk highly arched and rounded; in the centre a large hexagonal primary plate, surrounded by six others, much swollen, with inner and lateral sides nearly straight and outer edges rounded; these seven plates cover almost the entire upper surface of the disk; in the upper interbrachial space there is a rounded, much swollen marginal plate, and over the arm two small, joined, scale-like radial shields. On the under surface, outside the mouth shield, there are two large plates, the outer and larger one connected with the large marginal plate. Genital scale long and wide, and composed of three pieces. Tentacle scales, long, narrow, and curved, the one on the interbrachial side being semicircular, while the other on the lateral side of the under arm plate is small and lip-like. Two very short, blunt arm spines, placed low on the outer edge of the side arm plate. Colour in alcohol, pale straw.

A smaller specimen, with a disk of 2 mm., showed no special variations, except that the radial shields were relatively larger and there were only six primary plates, which is doubtless the normal number.

Station 164.—June 12, 1874; lat. 34° 8′ S., long. 152° 0′ E.; 950 fathoms; grey ooze. Station 165.—June 17, 1874; lat. 34° 50′ S., long. 155° 28′ E.; 2600 fathoms; red clay. Station 166.—June 23, 1874; lat. 38° 50′ S., long. 169° 20′ E.; 275 fathoms; globigerina ooze. Station 218.—March 1, 1875; lat. 2° 33′ S., long. 144° 4′ E.; 1070 fathoms; globigerina ooze.

Species of *Ophiomastus* not herein described.

Ophiomastus secundus, Lym. (Pl. XXXIX. figs. 14).

Ophiomastus secundus, Lym., Bull. Mus. Comp. Zool., vol. v., part 9, p. 218, pl. ii. figs. 16–18, 1878.

West Indies. 339 fathoms.

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Ophiophyllum.

Ophiophyllum, Lym., Bull. Mus. Comp. Zool., vol. v., part 7, 1878.

Disk extremely thin and flat, covered with scales and large radial shields, and bordered by a row of plates which are movable and attached by their inner margins. Mouth papillæ arranged in a close row; no tooth papillæ; teeth. Arm spines thin and broad, standing on outer edge of side arm plate. Two genital openings in each interbrachial space.

This singular genus has small relationship with any other. The fringe of thin plates is like that found in *Podophora* among echinoderms.

Ophiophyllum petilum, Lym. (Pl. XII. figs. 13–15).

Ophiophyllum petilum, Lym., Bull. Mus. Comp. Zool., vol. v., part 7, p. 130, pl. vii. figs. 179–181, 1878.

Fringe-like border of disk consisting of about a dozen very thin plates in each interbrachial space. One arm spine, which is wide and flat like a plate of the border. No tentacle scale.

(Type specimen from Station 174.) Diameter of disk 6 mm. Width of arm, without spines, close to the disk 1·2 mm. Six small, short, square, close-set mouth papillæ on either side of an angle, and three smaller diamond-shaped at the apex. Mouth shields rather large fan-shaped, with a deep curve without and an angle within; length to breadth 1 : 1·2. Side mouth shields narrow, bounding the inner angle of the mouth shield; outer ends square, inner ends tapering and separated. First under arm plate three sided, with a rounded angle inward, lateral sides straight, and outer edge curved; the rest are small and pentagonal, with an angle inward. Side arm plates broad and thin, meeting below beyond the second under arm plate, and just touching above beyond the third upper arm plate. Midway of the arm, where it is highly arched, they form most of its covering. Basal upper arm plates diamond-shaped; those beyond become more or less triangular, with a sharp angle inward, and outer edge slightly rounded. Disk flat and very thin, the centre covered with fine, thin, irregular scales; interbrachial space on margin filled by one large three-sided plate, with an angle inward and outer edge nearly straight. Radial shields large, three-sided, longer than wide, with outer angles slightly rounded, separated their entire length by a cluster of irregular scales larger than those of the centre; in the lower interbrachial space are two regular transverse rows of long and narrow plates. Genital scales small, much longer than wide, extending from the outer corners of the mouth shield to the disk margin. On the margin of the disk there is a fringe-like border of long, thin, rounded scales attached only by their inner margins, about twelve to each interbrachial space. Only one arm spine, which is attached to

lower edge of side arm plate, and is a broad rounded scale like those on the marginal border. No tentacle scales. Colour in alcohol, pale brown.

Station 171.—July 15, 1874; lat. 28° 33′ S., long. 177° 50′ W.; 600 fathoms (young). Station 174.—August 3, 1874; lat. 19° 10′ S., long. 178° 10′ E.; 210 to 610 fathoms; globigerina ooze.

Ophiotrochus.

Ophiotrochus, Lym., Bull. Mus. Comp. Zool., vol. v., part 7, 1878.

Disk flat and round, covered with thin, more or less granulated scales, and naked radial shields. Arms slender, tubular, each joint constricted at its base; side arm plates meeting widely above and below; upper arm plates rudimentary. Scale of second pair of mouth tentacles lying between side mouth shield and outer mouth papillæ. There are teeth and mouth papillæ; no tooth papillæ. Smooth arm spines on outer edges of side arm plates.

Ophiotrochus panniculus, Lym. (Pl. IX. figs. 12–14).

Ophiotrochus panniculus, Lym. Bull. Mus. Comp. Zool., vol. v., part 7, p. 129, pl. vi. figs. 158–160, 1878.

First arm joint, outside of disk, much wider than those beyond, and bearing four slender spines; the others have only two. A sparse granulation on the lower interbrachial space.

(Type specimen from Station 218.) Diameter of disk 6 mm. Length of arm 26 mm. Width of arm without spines ·8 mm. Two wide, very short, close-set mouth papillæ, occupying the whole of each side of an angle; and at the apex three more, very small, short, and spiniform. Mouth shields three-sided, with a long angle inward, and outer corners slightly rounded; length to breadth 1·3 : 1. Side mouth shields much longer than broad, swelled without like a knob, long and very narrow within, where they nearly or quite meet; they usually bear a few grains. First under arm plate small and rounded, with a slight peak inward; the rest are somewhat broader than long, pentagonal, with an angle inward, the outer edge rounded, and re-entering curves on the lateral sides. Side arm plates making together a tubular figure, flaring outward, meeting broadly below and above. Upper arm plates very minute, and almost disappearing towards middle of arm, situated at the outer junction of the side arm plates, three-sided, and with a peak within. Disk flat and round, covered with thin delicate scales; six rounded primary plates, separated by a line of scales, may be distinguished in the centre; the rest are more or less angular, and irregularly disposed. Radial shields broader than long, of irregular shape, with rounded angles, narrowly separated by a single line of scales. Interbrachial

space below covered with thin scales sparsely set with small grains, which stand also on the margin. Two large genital openings, extending from the outer corners of mouth shield to margin of disk. On first joint, outside disk, four sharp slender arm spines, placed high on side arm plate, the uppermost one as long as an arm joint, the others progressively shorter; on joints beyond there are only two short spines. One large rounded tentacle scale on the inner edge of each tentacle pore; the second pair of mouth tentacles have a wide flap-like scale hinged on the side mouth shield, and enclosed by the wide outer mouth papillæ. Colour in alcohol, very light grey.

This is one of the very few deep-sea species that have a loose granulation on the disk.

Other specimens had the disk scales more regularly disposed than in fig. 13, and the radial shields pear-seed shape with an angle inward.

Station 218.—March 1, 1875; lat. 2° 33′ S., long. 144° 4′ E.; 1070 fathoms; globigerina ooze.

Ophiopyren.

Ophiopyren, Lym., Bull. Mus. Comp. Zool., vol. v., part 7, 1878.

Disk granulated. Teeth; no tooth papillæ; numerous mouth papillæ arranged in a close line. Mouth frames long and conspicuous. Side mouth shields small[1] and widely separated by the mouth shield. Under arm plates divided in two parts by a crease or joint. Arm spines standing on outer edge of side arm plates. Two genital openings in each interbrachial space.

Ophiopyren stands, perhaps, near *Pectinura*, from which it is distinguished by the divided under arm plates and the tendency to minute grain-like papillæ along the genital opening. The peculiar division of the under arm plates by a crease or soldered joint rises in this way; near the tip of the arm the inner piece of the plate occupies most of the space, under the form of a long narrow plate having a sharp angle without, where are the tentacle pores bordered by a narrow rim, and this rim, growing gradually wider and thicker, forms the outer piece as it appears near the base of the arm.

Besides delicate imbricated scales, the disk is covered by flat, nearly semicircular, closely joined radial shields, to which are joined slender, rounded, slightly clubbed, genital plates, with a thin, blade-like genital scale. The arm bones, beyond the disk have an outer apophysis like that of *Ophioplax*. But the most striking feature is the double peristomial plate, one half stretching on either side, as a long narrow strip, from the outer corner of the mouth frame, to the centre of the mouth angle.

See Plate XXXIX. figs. 4–6.

[1] Their strict homology with the side arm plates is very plain in this genus, especially in *Ophiopyren longispinus*.

Ophiopyren brevispinus, Lym. (Pl. XII. figs. 1–3).

Ophiopyren brevispinus, Lym., Bull. Mus. Comp. Zool., vol. v., part 7, p. 133, pl. vii. figs. 173–175, 1878.

Three very short, blunt arm spines. Mouth shields longer than broad, pentagonal.

(Type specimen from Station 173.) Diameter of disk 3·8 mm. Width of arm without spines 1 mm. Thirteen or fourteen mouth papillæ to each angle, of which the outer one on each side is much the largest, and the rest are short and square, except the one at the apex, which is more pointed. Mouth shields longer than broad, pentagonal, with long pointed angle within; length to breadth ·8 : ·5. Side mouth shields squarish and very short, widely separated by inner angle of mouth shield. First under arm plate much broader than long, of an irregular oval form; second plate as long as broad, pentagonal, with a blunt angle inward; third plate similar, but with a sharper angle within; those beyond grow proportionately longer, and become gradually wedge-shape, with a truncated angle inward. Each plate is apparently divided in two parts, the inner one more or less diamond-shaped, the outer made up of the remainder of the plate. Upper arm plates four-sided, somewhat wider without than within, lateral sides straight, outer side slightly curved. Side arm plates not swollen, meeting neither above nor below. Disk flat and round, covered above and below with minute granules, about a dozen in the length of a millimetre. In lower interbrachial space on the side mouth shield next the genital opening are three minute grain-like papillæ. Radial shields small, partially covered by granulation, closely joined and much rounded within; just outside them is a row of large granules. Genital opening long, extending from side of mouth shield to edge of disk; genital scale hidden by granulation. Two short round tentacle scales on the second under arm plate; beyond, only one. Three very short, blunt, pointed arm spines, arranged evenly along the outer edge of the side arm plate. Colour in alcohol, white.

Station 173.—July 24, 1874; off Matuka Bay, Fiji; lat. 19° 10′ S., long. 179° 40′ E.; 300 fathoms; coral.

Ophiopyren longispinus, Lym. (Pl. XII. figs. 4–6; Pl. XXXIX. figs. 4–6).

Ophiopyren longispinus, Lym., Bull. Mus. Comp. Zool., vol. v., part 7, p. 134, pl. vii. figs. 176–178, 1878.

Three slender arm spines, as long as an arm joint. Mouth shields wide, heart-shaped, broader than long.

(Type specimen from Station 33.) Diameter of disk 4·5 mm. Width of arm, without spines, close to disk 1 mm. Fifteen or sixteen mouth papillæ to each angle, of which the outer one, on either side, stands on the side mouth shield, is larger than and separated from the others, and is sharp and curved; the rest are small, squarish, and close, except the one at the apex, which is sharp and longer. Mouth shields broader than long, three-

sided, outer edge straight, lateral corners much rounded, and an angle inward; length to breadth ·8 : 1. Side mouth shields squarish and large, widely separated by mouth shields, similar in form and position to the side arm plates beyond. First under arm plate small triangular, with an acute angle inward, and outer edge slightly curved; second plate four-sided, wider without than within; third plate as long as broad, much wider without than within, having outer corners rounded. All the plates are apparently composed of two pieces,—an inner, which has a sharp angle outward, and an outer, which comprises the rest of the plate. Side arm plates broad, not swollen, meeting neither above nor below. Upper arm plates wider without than within, considerably arched, and with outer corners prolonged in small peaks. Disk round and thick, covered above and below with very minute granulation, 15 or 20 grains in the length of a millimetre. Radial shields small, of a rounded pear-seed shape, nearly or quite joined, and to be seen only when the granulation has been removed. Genital openings extending from outer edge of mouth shield to margin of disk. Genital scales hidden by the skin and granulation. On the interbrachial edge of the side mouth shields are four short rounded papillæ. Three long, very delicate, pointed arm spines, the middle one a little the longest, upper and under spine of about the same size, and about as long as an arm joint. One long pointed tentacle scale on each of the first pair of tentacle pores; beyond there are two, one large and rounded, and one smaller and narrower. Colour in alcohol, white.

The description is from a specimen larger than the one figured.

A smaller specimen (Station 24) was more evenly granulated, and the radial shields were quite hidden. The upper arm plates were so thin as to show the arm bones through.

Station 24.—March 25, 1873; off Culebra Island; 390 fathoms; mud. Station 33.—April 4, 1873; off Bermudas; 435 fathoms; mud. Station 23.—March 15, 1873; off Sombrero Island; 450 fathoms; globigerina ooze.

Ophioconis.

Ophioconis, Ltk., Addit. ad Hist., part 3, 1869.

Entire disk, including more or less of the mouth angles, covered by a close and fine granulation. Numerous (7–9), slender, hollow arm spines. Numerous (10–14) small close-set mouth papillæ to each angle. Teeth. Few or no tooth papillæ. Two genital openings in each brachial space.

A general delicacy of structure characterises the skeleton (*Ophioconis miliaria*) including the disk scales which are small and thin, and the radial shields which are small and separated. Genital plate rather weak, and flattened, with a slightly clubbed head, and a thin genital scale attached at some distance inward. The mouth frames, which

are large and flaring, sometimes have their outer open angle closed by a veil of thin ill-defined lime scales, which running up to the peristomial plate may be of one, two, or three pieces. On their outer and inner faces, the arm bones do not much depart from the type, but those near the edge of the disk have a forward projection on their upper surface.

See Plate XXXIX. figs. 7–9.

Table of Species of *Ophioconis*.

Seven slender cylindrical tapering nearly equal, arm spines, about as long as an arm joint. Disk wholly granulated above and below, with about 14 grains in the length of a millimetre. One or two tentacle scales, . .	*Ophioconis forbesii.*
Similar to preceding but only six arm spines, about half as long as a joint,	*Ophioconis brevispina.*
Seven slender arm spines, the two uppermost longest. Disk wholly granulated except mouth shield with about 6 grains in the length of a millimetre. One large tentacle scale, ...	*Ophioconis antarctica.*
Seven to eight arm spines, the uppermost as long as three arm joints. Disk wholly granulated: about 13 grains in the length of a millimetre. Two tentacle scales, ...	*Ophioconis miliaria.*
Similar to preceding, but eight to nine arm spines, some of which are flattened and almost spatulate, ...	*Ophioconis pulverulenta.*

Ophioconis antarctica, Lym. (Pl. XXIII. figs. 1–3).

Ophioconis antarctica, Lym., Bull. Mus. Comp. Zool., vol. vi., part 2, p. 44, 1879, pl. xiv. figs. 380–382.

Seven slender, cylindrical, tapering arm spines, the two upper ones longest. One large tentacle scale. Disk closely granulated, except mouth shield; 5 or 6 grains in the length of 1 mm.

(Type specimen from Station 150.) Diameter of disk 13 mm. Length of arm about 60 mm. Width of arm at base, without spines, 2 mm. There are to each angle of the mouth twelve or fourteen papillæ, of which the innermost are slender and pointed, while the outer one on either side is broad and squarish; at the apex there is a cluster of four or five, which properly might be called tooth papillæ. Five or six rather narrow, flat, blunt teeth, whereof the lowest is often split in two. Mouth shields broad triangular, with a blunt angle inward and outer edge nearly straight; they are more or less obscured by granules, which completely hide the side mouth shields. These are small, longer than wide, and broader without than within, where they nearly or quite meet. Under arm plates much broader than long, pentagonal, with a blunt inner angle, outer edge slightly curved, and laterals re-enteringly curved. Side arm plates somewhat projecting, nearly

meeting below, but well separated above by the thick, broad, somewhat arched upper arm plates, which are wide fan-shaped, with a blunt angle inward. Under the microscope they appear minutely tuberculous, while the lower plates are ornamented with wavy lines. Disk thick and nearly round, completely covered with coarse, rounded granules, five or six in the length of 1 mm. on the upper surface, and more scattered below. The underlying scales are extremely thin and smooth. Genital openings long, extending from outer corners of mouth shield nearly or quite to the margin of disk. Seven long, smooth, cylindrical, tapering arm spines, the two upper ones as long as three or four arm joints; the others somewhat shorter. One long, wide tentacle scale, with a rounded point occupying the lateral side of the under arm plate. Colour in alcohol, nearly white.

Station 150.—February 2, 1874; lat. 52° 4′ S., long. 71° 22′ E.; 150 fathoms; rock. Off Prince Edward Island; 85 to 150 fathoms. Off Marion Island; 50 to 75 fathoms.

Ophioconis pulverulenta, Lym. (Pl. XXIII. figs. 4–6).

Ophioconis pulverulenta, Lym., Bull. Mus. Comp. Zool., vol. vi., part 2, p. 45, 1879, pl. xiv. figs. 377–379.

Disk finely, closely, and evenly granulated, with about 14 grains in the length of 1 mm. Eight or nine long, delicate, somewhat flattened arm spines, the three uppermost longest, and nearly equal. Two tentacle scales.

(Type specimen from Station 172.) Diameter of disk 12 mm. Length of arm about 55 mm. Width of arm close to disk, without spines, 3·2 mm. Ten small, short, close-set, pointed mouth papillæ on each side of the mouth angle, and one somewhat stouter at the apex; the two outermost are broadest and most rounded. Mouth shields large, as broad as long, of a rounded heart-shape. Side mouth shields stout and wide, broader without than within, where they do not meet. Both they and the mouth shields are more or less covered by a granulation, which, as well as that of the disk, is liable to be rubbed off. Under arm plates axe-shaped, much broader without, where the edge is curved, and with deep re-entering curves on the lateral sides. Side arm plates thin and microscopically corrugated. Upper arm plates thin, with a central ridge, about twice as broad as long, much wider without than within, with sharp outer lateral corners and straight sides. Disk round and quite thick closely and evenly covered with minute granules, twelve or fourteen in the length of 1 mm. Underneath these granules there are fine uniform, overlapping scales, about five in the length of 1 mm., among which the radial shields cannot be distinguished. Eight or nine long, slender, tapering, flattened arm spines, whereof the three uppermost are about 2·3 mm. long and nearly equal, and the other five or six from 2 mm. to 1·7 mm. long. Two long, thin, nearly oval

tentacle scales, which are two-thirds as long as an under arm plate. Colour in alcohol, pale straw.

Station 172.—July 22, 1874 ; off Nukualofa, Tongatabu ; 240 fathoms ; coral.

This species stands very close to *Ophioconis miliaria* of the West Indies, and comes from a similar depth. It seems sufficiently distinguished by the arm spines, which are more numerous by one or two, and more flattened, showing even a feeble tendency to become spatulate.

Species of *Ophioconis* not herein described.

Ophioconis forbesii, Ltk., Addit. ad Hist., part 3, p. 98, 1869 ; Ludwig, Echin. des. Mittelmeeres, p. 546.

Pectinura forbesii, Heller, Lit. Fauna d. Adriat. Meeres, 1862, p. 422, pl. ii. figs. 5–8 ; Zooph. u. Echin. Adriat. Meeres, p. 57.

Adriatic ; 15 to 50 fathoms.

Ophioconis miliaria, Lym. (Pl. XXXIX. figs. 7–9).

Ophioconis miliaria, Lym., Bull. Mus. Comp. Zool., vol. v., part 9, p. 221, pl. iii. figs. 49–51, 1878.

Off Havana ; 450 fathoms.

Ophioconis brevispina, Ludwig, Mittheil. der Zool. Station, Neapel., vol. ii. p. 61, pl. iv. figs. 3^a, 3^b, 1880.

Mediterranean.

Ophiochæta.

Ophiochæta, Ltk., Addit. ad Hist., part 3, 1869.

Disk densely covered with smooth spines, or spines and grains. Numerous (7–10) slender hollow spines. Numerous (10–14) small close-set mouth papillæ. Teeth, but no tooth papillæ. Two genital openings in each interbrachial space.

In general appearance, the skeleton (*Ophiochæta mixta*) bears a likeness to that of *Ophioconis*. The mouth frames are, however, smaller and more compact, their top being covered by a stout three-sided peristomial plate, in one or two pieces, while their outer open angle is more or less veiled by a thin lime crust. To the high, thin, and even genital plate is attached a very thin scale of similar form and equal length. The arm bones are delicate with thin wings ; those near the margin of the disk have an outer projection on top. The scale-coat of the disk is fine and closely soldered, and the radial shields of moderate size, three-sided and separated.

See Plate XXXIX. figs. 15–17.

Ophiochæta setosa, Ltk., Addit. ad Hist., part 3, p. 38, 1869; Ljn., Dr. Goës, Oph. Öf. Kong. Akad., p. 639, 1871.

Fiji Islands.

Species of *Ophiochæta* not herein described.

Ophiochæta (?) *mixta*, Lym. (Pl. XXXIX. figs. 15–17).

Ophiochæta (?) *mixta*, Lym., Bull. Mus. Comp. Zool., vol. v., pt. 9, p. 222, pl. ii. figs. 40–42, 1878.

West Indies; 160 to 242 fathoms.

GROUP II.—Arm spines on sides of side arm plates and at a strong angle to arm.

Ophiopholis (*Ophiolepis*).

Ophiopholis, Müll. & Tr., Syst. Ast., 1842.

Disk more or less covered with grains, or little spines. Teeth. No tooth papillæ. Mouth papillæ on the sides of the mouth frames. Arm spines short, flat, and stout. Upper arm plates surrounded by a rim of supplementary pieces. The lowest spine of the outer arm joints is a hook. General structure rather coarse and stout. Two genital openings beginning outside the mouth shields.

The disk covering, seen from within, consists of overlapping scales, and large, rather thin, radial shields. To the outer end of the genital plate, which is remarkable for its thick, tapering, cylindrical form, is attached a small, very short, curved scale. The peristomial plate is small and linear, just covering the nerve ring. Otherwise of the normal type, the arm bones are somewhat remarkable for their large wings.

TABLE OF SPECIES OF *Ophiopholis*.

Radial shields and most of upper disk naked: edges of disk and interbrachial spaces below sparsely granulated, or set with minute spines. Arm spines longer and more slender than in the other species, . . .	*Ophiopholis japonica.*
Radial shields and primary plates naked, and separated by lines of granules or minute spines, which are continued on the interbrachial spaces below. Arm spines thick and blunt, ...	*Ophiopholis mirabilis.*
Disk wholly granulate or minutely spined except primary plates. Arm spines thick and blunt, ...	*Ophiopholis aculeata.*
Similar to preceding, but only primary plates of brachial spaces are naked, .	*Ophiopholis kennerlyi.*
Similar to preceding, but entire disk above and interbrachial spaces below granulate, or spinous, ...	*Ophiopholis caryi.*

Ophiopholis japonica, Lym. (Pl. XXIII. figs. 13–15).

Ophiopholis japonica, Lym., Bull. Mus. Comp. Zool., vol. vi., part 2, p. 42, pl. xiii. figs. 374–376, 1879.

Upper disk covered with thin scales and large radial shields, neither of which have grains or spines, except the marginal scales. Five stout, cylindrical, tapering arm spines.

(Type specimen from Station 236.) Diameter of disk 10 mm. Length of arm about 40 mm. Width of arm without spines near disk 2·7 mm. Three or four small, irregular, flat, scale-like mouth papillæ on each side, and a flat clump of short, bead-like tooth papillæ at apex of mouth angle. Mouth shields and side mouth shields somewhat obscured by thick skin. The former are transverse oval, much wider than long; length to breadth ·8 : 1·3. Side mouth shields small and short, with rounded ends, rather wider within than without, and somewhat bent. Under arm plates a little wider than long, slightly separated, and with rounded corners. Side arm plates closely soldered with their neighbours, meeting neither above nor below, rising laterally in a strong spine ridge. Upper arm plates transverse oval, twice as broad as long, slightly swollen, each surrounded by a single line of rounded granules, which are broader than long. Disk round and thick, with a flat top, covered with thin, variously-shaped scales, which, near the margin, are obscured by thick skin; those of the centre small, round, and arranged in a rosette; those farther out, larger and elongated, arranged in three or four rows between the radial shields in the interbrachial spaces, where they are beset with a few scattered grains, which at the margin become much more numerous and larger, and appear as very short spines. Interbrachial spaces below covered with a few grain-like spines. Radial shields large, pear-seed shaped, much longer than wide, separated usually by a line of two large and two small scales. Genital openings large and extending about two-thirds the distance to the margin. Five, rarely six, stout cylindrical, blunt, tapering arm spines, whereof the second and third are stoutest, and as long as one and a half arm joints. One, and on the first two joints sometimes two, small, rounded tentacle scales. At tip of arm are four slender spines, of which the lowest takes the form of a flat, long, three toothed hook, as elsewhere in this genus. Colour in alcohol, above, light pink; below, pale straw.

It is evident that *Ophiolepis mirabilis*,[1] Duncan, is a true *Ophiopholis*, lacking none of its characters, and standing quite near the typical *Ophiopholis aculeata*. The fact that certain small scales surround larger ones is not here of generic importance, and probably results from the young stage of the specimen, which, to judge from the figures, had a disk not exceeding 4 mm. in diameter. *Ophiopholis japonica* differs from the old species as well as from *Ophiopholis mirabilis* in its more slender arm spines, and in having the radial shields and much of the upper disk free of grains or spines.

Station 235.—June 4, 1875; lat. 34° 7′ N., long. 138° 0′ E.; 565 fathoms; mud.
Station 236.—June 5, 1875; lat. 34° 58′ N., long. 139° 30′ E.; 420 to 775 fathoms; mud.

[1] P. M. Duncan, Linn. Soc. Journ. Zool., vol. xiv. pp. 460 and 479.

Species of *Ophiopholis* not herein described.

Ophiopholis aculeata, Gray (Pl. XLVI. fig. 6).

Ophiopholis aculeata, Gray, Rad. Animals Brit. Mus., p. 25, 1848; Ltk., Addit. ad Hist., part 1, p. 60, pl. ii. figs. 15, 16.
Bellis scolopendrica, Linck, De Stel. Mar., p. 52, pl. xl. fig. 71, 1733.
Asterias aculeata, Linn., Syst. Nat. (Gmel.), p. 3166, 1788.
Asterias ophiura, Fabr., Fauna Grœn., p. 371, 1780.
Asterias aculeata, Retz., Asteriæ Gen., p. 240, 1783.
Asterias aculeata, Abildgaard, in Müller, Zool. Dan., p. 29, pl. xcix., 1789.
Ophiura flemingii et Ophiura ammothea, Leach, Zool. Misc., vol. ii. pp. 55, 56, pl. lxxix. figs. 1–3.
Ophiura bellis, Flem., Edin. Phil. Journ., vol. viii. p. 298; Brit. Anim., p. 488; Johnston, Mag. Nat. Hist., p. 595.
Ophiocoma bellis, Fbs., Wern. Mem., vol. viii. p. 126; Brit. Starfishes, p. 53.
Ophiolepis (*Ophiopholis*) *scolopendrica*, Müll. & Tr., Wieg. Archiv., p. 328; Syst. Ast., p. 96.
Ophiopholis bellis, Lym., Ill. Cat. Mus. Comp. Zool., No. i. p. 96, pl. i. figs. 4–6.
Polypholis echinata (?), Duncan, Journ. Linn. Soc., vol. xv. p. 73, pl. iii. (Young).

North-east America; North European and Arctic seas; littoral to 400 fathoms.

Ophiopholis kennerlyi, Lym., Proc. Bost. Soc. Nat. Hist., vol. vii. p. 200, 1860; Ill. Cat. Mus. Comp. Zool., No. i. p. 100.

Puget Sound to Mendocino, California.

Ophiopholis caryi, Lym., Proc. Bost. Soc. Nat. Hist., vol. vii. p. 261, 1860; Ill. Cat. Mus. Comp. Zool., No. i. p. 101.

Queen Charlotte Island (?), Coast of California; littoral to 22 fathoms.

Ophiopholis mirabilis, Lym., Bull. Mus. Comp. Zool., vol. vi. part 2, p. 43.

Ophiolepis mirabilis, Duncan, Journ. Linn. Soc., vol. xiv. p. 460, pls. ix. and x. figs. 12–14.

Korean Sea.

Ophiactis.

Ophiactis, Ltk., Vid. Meddel, 1856.

Disk circular, robust, closely covered with radial shields and overlapping scales, the latter bearing usually a greater or less number of small spines. Teeth. No tooth papillæ. Mouth angles small and narrow, and bearing a few (usually two or four) small mouth papillæ. Arms stout, somewhat flattened, of moderate length (four to seven times diameter of disk). Arm spines stout, smooth, and solid. Two genital openings beginning outside the mouth shields.

In respect to disk scales and radial shields the arrangement resembles that of *Ophiopholis* (especially in *Ophiactis asperula*), though other species (*e.g.*, *Ophiactis cuspidata*) have much larger and stouter scales. There is a resemblance likewise in the peristomial plate which is wanting (*Ophiactis kröyeri*), or is a mere thin crust (*Ophiactis savignyi*), or is small and linear (*Ophiactis asperula*). The genital plate is usually very stout, though long, slender, and cylindrical in *Ophiactis kröyeri*, and has attached to it a considerably shorter genital scale. The arm bones are discoid and delicate, with thin wings.

Table of Species of *Ophiactis*.

1st Type. The number of mouth papillæ increase with age.

Six to seven short, thick, blunt rough arm spines. Young usually with six arms; adult often with only five. Commonly two mouth papillæ on each side; rarely more. Upper arm plates microscopically tuberculous, swollen, usually with a faint lobe on the outer edge. Radial shields large, scarcely diverging, nearly or quite touching. Side mouth shields nearly or quite meeting at their outer ends. Numerous disk spines, ...	*Ophiactis savignyi.*
Radial shields narrow, oval, and separated. Upper arm plates wider than long, with lateral sides re-enteringly curved. Under arm plates broader than long, and cleanly curved without, ...	*Ophiactis affinis.*
The adult (var. *quinqueradia*) has five arms; upper arm plates transverse oval, and not thickened; three or even four mouth papillæ on a side. The young is like *Savignyi* (six arms), but has no lobe on upper arm plate, .	*Ophiactis mülleri.*
Skin thick and much obscuring the scaling and mouth shields. Radial shields narrow and small. Five short, thick, blunt, flattened arm spines,	*Ophiactis resiliens.*

2nd Type. The number of mouth papillæ seems never to vary.

Small radial shields, just touching without, widely diverging inward, four stout and blunt, but cylindrical and tapering, arm spines. Disk scales curved and regularly imbricated. Upper arm plates fan-shaped and symmetrical. A few disk spines. One mouth papilla, ...	*Ophiactis balli.*
Differs from preceding in disk scales less overlapping; two mouth papillæ on each side, and side mouth shields not meeting without, . . .	*Ophiactis asperula.*
Six arms; two mouth papillæ on each side. Radial shields proportionately larger than in *Ophiactis balli*, upper and under arm plates longer, and disk scales less regular. Side mouth shields not meeting without (young?)	*Ophiactis loricata.*
Differs from *Ophiactis balli* in under arm plates, from *loricata* in fan shaped upper arm plates, ...	*Ophiactis lymani.*
Near *Ophiactis balli*, but only three arm spines; no disk spines. Teeth lobed. Side mouth shields not meeting without, ...	*Ophiactis plana.*
Disk scales distinct and naked, without spines. Three stout, blunt, tapering, cylindrical arm spines. One large flat mouth papilla on each side. Teeth lobed. Five arms, ...	*Ophiactis flexuosa.*
Differs from *Ophiactis balli* in arched disk with radial shields not well distinguished from other scales; and in transverse oval upper arm plates, .	*Ophiactis virens.*

Table of Species of *Ophiactis*—continued.

Disk scales thick and swollen: upper arm plates wide, transverse oval, not swollen. Side mouth shields making a connected ring. Four or five stout but not swollen arm spines. Small disk spines, . . .	*Ophiactis simplex.*
Differs from *Ophiactis simplex* in wanting disk spines; in radial shields scarcely to be distinguished from scales (which are less imbricated than in *simplex*) and in more oval upper arm plates, ...	*Ophiactis arenosa.*
Disk scaling coarse, and with few or no spines. Three or four stout, blunt, tapering arm spines. Two or three mouth papillæ on each side. Teeth lobed, ...	*Ophiactis cuspidata.*
Disk without spines, and covered with thick, rounded scales, whereof the largest are near the radial shields. Two small tentacle scales, . .	*Ophiactis pectorale.*
Disk scales coarse, and set with numerous short spines. Radial shields short and triangular. Four stout, cylindrical, tapering arm spines. One mouth papilla on each side. Five arms, ...	*Ophiactis nama.*
Mouth shields very wide and short. Always one mouth papilla on each side, four to five stout smooth long arm spines, usually blunt and tapering, but sometimes the upper ones much swollen; middle ones longest. Disk scales coarse above and below with variable number of spines. Radial shields larger than in the type *Ophiactis balli*, ...	*Ophiactis kröyeri.*
Large (disk 11–12 mm.) nearly black. Four arm spines; upper one longest. Radial shields shagreened, small, and rudely diverging. Under arm plates curved without and within; re-enteringly curved on sides. Upper arm plates truncated fan shape, ...	*Ophiactis nigrescens.*
Five short, smooth, tapering arm spines. Disk scales smooth and rather fine. Upper arm plates rounded fan shape, not swollen. One mouth papilla on each side, ...	*Ophiactis maculosa.*
Disk finely scaled, and set with short, minute spines. Radial shields small and pear-seed shaped. Four moderately stout tapering arm spines, the uppermost longest. Two or three minute mouth papillæ on each side. Seven arms, ...	*Ophiactis hirta.*
Disk scales coarse and thick, with large radial shields; no spines except a few near the margin. Four rather long and slender arm spines, the upper one longest. Two mouth papillæ on each side, ...	*Ophiactis poa.*
Disk scales larger in centre, where primary plates may be distinguished in a rosette; no spines, or only an occasional minute one on the margin. Three or four rather long and tapering arm spines Two mouth papillæ on each side, ...	*Ophiactis canotia.*
Four long, rather slender arm spines. Many strong disk spines. Disk scales thick and somewhat irregular. Two mouth papillæ on each side. Teeth lobed, ...	*Ophiactis abyssicola.*
Structure more delicate. One mouth papilla. Radial shields very small. Disk scales small, fine and regular. Four arm spines about as large as in *Ophiactis asperula*. Upper arm plates clean, transverse oval, . .	*Ophiactis carnea.*

Ophiactis savignyi, Ljn., Oph. Viv. Öf. Kong. Akad., p. 323, 1866.

Ophiolepis Savignyi, Müll. & Tr., Syst. Ast., p. 95; Savigny, Descr. de l'Egypte, Echin., pl. ii. figs. 4–5.
Ophiolepis sexradia, Grube, Wieg. Archiv, p. 343, 1857.
Ophiactis sexradia, Ltk., Addit. ad Hist., pt. 2, p. 126; Lym., Ill. Cat. Mus. Comp. Zool., No. i. p. 115.
Ophiactis Reinhardti, Ltk., Addit. ad Hist., part 2, p. 161, pl. iii. fig. 7, 1859.
Ophiactis Krebsii, Ltk., Vid. Meddel., p. 12, 1856; Addit. ad Hist., part 2, p. 126. Lym., Ill. Cat. Mus. Comp. Zool., No. i. p. 111, figs 10–11.
Ophiactis incisa, V. Mart., Wieg. Archiv, p. 248, 1870.
Ophiactis virescens, Örst. & Ltk., Vid. Meddel., March, 1856, p. 24; Addit. ad Hist., part 2, p. 128; Vll., Trans. Conn. Acad., vol. i., part 2, p. 265.

Samboangan; 10 fathoms. Station 208.—January 17, 1875; lat. 11° 37′ N., long. 123° 32′ E.; 18 fathoms; mud.

Ophiactis mülleri, Ltk., Vid. Meddel., Jan. 1856, p. 12; Addit. ad Hist., pt. 2, p. 127. Lym., Ill. Cat. Mus. Comp. Zool., No. i. p. 109; Bull. Mus. Comp. Zool., vol. v., pt. 9, p. 224.

Off Bahia, Brazil; 7 to 20 fathoms, var. *quinqueradia*. Station 122.—September 10, 1873; lat. 9° 10′ S., long. 34° 50′ W.; 350 fathoms; mud.

Ophiactis resiliens, Lym. (Pl. XX. figs. 7–9).

Ophiactis resiliens, Lym., Bull. Mus. Comp. Zool., vol. vi., pt. 2, p. 36, pl. xiii. figs. 362–364, 1879.

Skin thick and much obscuring the scaling and mouth shields. Radial shields narrow and small. Five short, thick, blunt, flattened arm spines.

(Type specimen from Port Jackson.) Diameter of disk 6·5 mm. Length of arm 38 mm. Width of arm near disk 1·5. Mouth angle very small and short, carrying on either side two small, flat, squarish papillæ, and, at its apex, a third, rounded, with a minute point like the teeth. Mouth shields small, of a transverse oval shape; length to breadth ·7 : ·5. Side mouth shields rather small and curved, broader without than within, where they meet. Under arm plates small and rounded, about as long as broad, having outer side curved and inner side with ill-marked angles. Side arm plates projecting in a strong spine ridge. Upper arm plates flat, transverse oval in form, about twice as broad as long. Disk covered below by a thick, naked skin, and above by fine, crowded, irregular, thin scales, of the smallest of which there are about five in the length of 1 mm. Those near the radial shields are much larger; and there may be also obscurely distinguished six round primary plates, widely separated by the fine scaling. The disk margin is beset with minute, sharp, peg-like spines. Radial shields long and narrow, touching without, separated within by a narrow wedge of about three scales; length to breadth 1·3 : ·4. Five short, thick, blunt, flattened arm spines, of which the uppermost is the stoutest, but not longer than the rest. One oval tentacle scale. Colour in alcohol, above, olive, mottled and banded with lighter green; below, yellowish-brown, with under arm plates and arm spines marked with orange.

Port Jackson, Australia; 30 to 35 fathoms.

Ophiactis asperula, Ltk., Addit. ad Hist., part 2, p. 130, 1859.

Ophiolepis asperula, Phil., Weig. Archiv, p. 267, 1858.

Ophiactis magellanica, Ljn., Om nägra nya arter, Öf. Kong. Akad., 1866, p. 164; Oph. Viv. Öf. Kong. Akad., p. 325.

West and south-east coasts of Patagonia; 44 to 315 fathoms. Chili; 44 fathoms. Station 308.—January 5, 1876; lat. 50° 10′ S., long. 74° 42′ W.; 175 fathoms; mud. Station 311.—January 11, 1876; lat. 52° 50′ S., long. 73° 53′ W.; 245 fathoms; mud. Station 312.—January 13, 1876; lat. 53° 38′ S., long. 70° 56′ W.; 10 to 15 fathoms; mud. Station 315.—January 26, 27, 28, 1876; lat. 51° 40′ S., long. 57° 50′ W.; 5 to 12 fathoms; sand and gravel.

Ophiactis flexuosa, Lym. (Pl. XX. figs. 1–3).

Ophiactis flexuosa, Lym., Bull. Mus. Comp. Zool., vol. vi., pt. 2, p. 37, pl. xiii. figs. 347–349, 1879.

Disk scales distinct and naked, without spines. Three stout, blunt, tapering, cylindrical arm spines. One large, flat mouth papilla on each side. Teeth lobed. Five arms.

(Type specimen from Station 171.) Diameter of disk 7 mm. Length of arm about 35 mm. Width of arm near disk 2·3 mm. Each side of the short, narrow mouth angle is occupied by a single very large, wide, flat papilla, while a third, standing under and resembling the teeth, is at the apex, and has a rounded figure, with a decided peak or little lobe within. Mouth shield somewhat broader than long, of a rounded diamond shape. Side mouth shields rather broad, wider without than within where they meet. First under arm plate small, and wider within than without; those beyond are narrow compared with the width of the arm, much rounded, of a short transverse oval shape, with the inner side somewhat angular. Side arm plates very wide, meeting neither above nor below, and having but a feeble lateral projection. Upper arm plates broad and short, two and a half times as wide as long, of an elongated transverse diamond form, sometimes with outer side so straight as nearly to be triangular. Disk without spines, and covered above with coarse, rounded, thick, overlapping scales, of which there are four or five radiating rows in the narrowest part of each interbrachial space. Below, the scales of the interbrachial space are much finer (four or five in the length of 1 mm.), and regularly imbricated. Three short, stout, cylindrical, scarcely tapering arm spines of nearly equal length, and about as long as one and a half joints; the upper spine stoutest. One large oval tentacle scale. Colour in alcohol, pale brown.

Station 171.—July 15, 1874; lat. 28° 33′ S., long. 177° 50′ W.; 600 fathoms; rock. Station 142.—Dec. 18, 1873; lat. 35° 4′ S., long. 18° 37′ E.; 150 fathoms (young?); sand.

The ten specimens from Station 142, 150 fathoms, may be the young of this species. They have six arms, while *Ophiactis flexuosa* has but five, and are scarcely to be distinguished from *Ophiactis plana*; and the question arises whether *Ophiactis plana* be not a young animal. The so-called adult of *Ophiactis mülleri* has five arms, and the young six.

Ophiactis cuspidata, Lym. (Pl. XX. figs. 10–12).

Ophiactis cuspidata, Lym., Bull. Mus. Comp. Zool., vol. vi., part 2, p. 38., 1879, pl. xiii. figs. 359–361.

Disk scaling coarse, and with few or no spines. Three or four stout, blunt, tapering arm spines. Two or three mouth papillæ on each side. Teeth lobed.

(Type specimen from Station 170.) Diameter of disk 5 mm. Length of arm 25 mm. Width of arm close to disk 1·3 mm. Two large, broad, flat mouth papillæ on each side, whereof the outer one is larger. Seven or eight large, flat teeth, of a very wide heart shape, and having a little lobe, or peak, within. Mouth shields broader than long, wide heart shape, or transverse diamond shape, with rounded angles; length to breadth ·6 : ·8. Side mouth shields stout, slightly curved, rather broad, meeting within, where they have a rounded end. First under arm plate stout and rather large, wider within than without, and having re-enteringly curved lateral sides. The plates beyond are shield shaped, widest without, and having a somewhat obtuse angle within. Outer side curved, lateral sides re-enteringly curved. Side arm plates stout, nearly meeting above and below, and having a well-marked spine crest. Upper arm plates broader than long, of a wide, transverse diamond shape, with the outer angle much rounded. Disk thick and covered above with large, rather swollen scales, whereof there are three lines in each interbrachial space; in the centre are six large, somewhat angular, primary plates, separated by single lines of much smaller angular scales; the lower interbrachial space is covered with fine, thickened scales, from five to eight in the length of 1 mm. Radial shields blunt pear-seed shape, swollen; nearly or quite separated by a wide wedge of two or three scales. Along margin of disk are a few small, peg-like spines. Four stout, smooth, tapering, regular arm spines, the upper one longest; lengths to that of a lower arm plate 1·7, 1·1 1, ·7 : ·6. One stout, nearly oval tentacle scale. Colour in alcohol, pale grey.

Station 170.—July 14, 1874; lat. 29° 55′ S., long. 178° 14′ W.; 520 fathoms. Station 171.—July 15, 1874; lat. 28° 33′ S., long. 177° 50′ W.; 600 fathoms.

Ophiactis nama, Lym. (Pl. XX. figs. 16–18).

Ophiactis nama, Lym., Bull. Mus. Comp. Zool., vol. vi., part 2, p. 38, pl. xiii. figs. 350–352, 1879.

Disk scales coarse, and set with numerous short spines. Radial shields short and triangular. Four stout, cylindrical, tapering arm spines. One mouth papilla on each side. Five arms.

(Type specimen from Station 174.) Diameter of disk 6 mm. Length of arm about 45 mm. Width of arm near disk 2·2 mm. One large, wide, flat mouth papilla at base of mouth angle on each side, and one (which may be called the lowest tooth) at the apex; this last is broad and rounded, with a minute peak within. Mouth shields of a much rounded, transverse diamond shape; length to breadth 8 : 1·1. Side mouth shields stout,

nearly meeting without, broader without than within, where they touch. First under arm plate small and three-sided, wider within than without; those beyond are one-half broader than long, with a curved outer side, and an irregular, more or less truncated angle within. Side arm plates unusually wide, but not much projecting, nearly meeting above and below. Upper arm plates much wider than long, three-sided, with a faintly curved outer side, and an angle, sometimes truncated, within. Disk plentifully set with short, slender, cylindrical spines, and covered with well rounded overlapping scales, which are large above (two or three in the length of 1 mm.), and more regular and much smaller below (four or five in 1 mm.). Radial shields sunken, rudely triangular, short and wide, separated by a broad wedge of three or four large scales; length to breadth 1·2 : 1. Four cylindrical, tapering, blunt, rather stout arm spines, the two upper ones largest and somewhat longer than an arm joint. One large, oval tentacle scale. Colour in alcohol, pale straw.

Station 174.—August 3, 1874; lat. 19° 10′ S., long. 178° 10′ E.; 210 to 610 fathoms; globigerina ooze. Station 171.—July 15, 1874; lat. 28° 33′ S., long. 177° 50′ W.; 600 fathoms.

Ophiactis hirta, Lym. (Pl. XX. figs. 4–6).

Ophiactis hirta, Lym., Bull. Mus. Comp. Zool., vol. vi., part 2, p. 39, pl. xiii. figs. 365–367, 1879.

Disk finely scaled, and set with short minute spines. Radial shields small and pear-seed shaped. Four moderately stout tapering arm spines, the uppermost longest. Two or three minute mouth papillæ on each side. Seven arms.

(Type specimen from Station 164*a*.) Diameter of disk 4·3 mm. Length of arm about 14 mm. Width of arm near disk 1·2 mm. Two or three small, narrow, scale-like mouth papillæ on either side of the very narrow mouth angle; and one wide, flat, and pointed at the apex; this last may, as in all similar cases, be considered the lowest tooth. Mouth shields small, of a much rounded diamond shape; sometimes nearly circular. Side mouth shields narrow, of nearly equal width, meeting within. Under arm plates rather small, as broad as long, bounded without by a strong curve, and within by three sides of an octagon. Side arm plates stout, projecting laterally in a well-marked spine ridge, meeting neither above nor below. Upper arm plates a little broader than long, transverse oval, with the inner sides more or less angular. Disk covered with coarse, thickened, irregular scales, those of the under surface being sometimes wholly obscured by a thick skin; those in the centre are largest, but the primary plates are not readily distinguishable; there are small, peg-like spines scattered over the entire surface. There are seven pairs of radial shields, which are small, sunken below the disk surface, of a blunt pear-seed shape, and separated by a rather wide wedge of three scales. Four smooth, rounded, tapering, moderately stout arm-spines; the upper one longest; lengths to that of an under arm

plate, 1,·8,·7,·7 : ·5. One stout, oval tentacle scale. Colour in alcohol, grey mottled with pale brown.

Station 164*a*.—Lat. 34° 19′ S., long. 151° 31′ E.; 400 fathoms; grey ooze.

Ophiactis poa, Lym. (Pl. XX. figs. 13–15).

Ophiactis poa, Lym., Bull. Mus. Comp. Zool., vol. vi., part 2, p. 40, pl. xiii. figs. 356–358, 1879.

Disk scales coarse and thick, with large radial shields; no spines except a few near the margin. Four rather long and slender arm spines, the upper one longest. Two mouth papillæ on each side.

Diameter of disk 5 mm. Length of arm about 30 mm. Width of arm near disk 1 mm. on each side of the short narrow mouth angle are two rather large, squarish, flat papillæ, of which the outer one is broader; at the apex is usually a very small heart-shaped papilla, similar in shape to the larger teeth above it. Mouth shields much wider than long, of a rounded transverse heart shape; the inner sides a little re-enteringly curved. Side mouth shields of nearly equal width, meeting broadly within. Under arm plates wide shield shaped, bounded without by a broad curve, within by an obtuse or truncated angle, and on the lateral sides by re-entering curves. Side arm plates nearly meeting above and below, not very wide, but projecting, in a well-marked spine crest. Upper arm plates broader than long, fan shaped with an obtuse angle inward. Disk covered with coarse, overlapping scales; those below regular and smaller, about four in the length of 1 mm.; those above much larger and more irregular; in the centre an irregular rosette of large, rounded plates, and in each interbrachial space about three radiating rows of elongated scales. The disk margin is sparsely set with small peg-like spines. Radial shields large, of an angular pear-seed shape, separated wholly by a narrow wedge of two or three scales; length to breadth 1·5 : 1. Four slender, cylindrical tapering arm spines, the uppermost longest; lengths to that of an under arm plate 1·2, ·8, ·8, ·8 : ·5. One large, oval tentacle scale. Colour in alcohol, pale grey.

Off Tristan d'Acunha; 1000 fathoms. Off Tristan d'Acunha; 500 fathoms. Both Station 135.—October 16, 17, 18, 1873; rock, shells.

Ophiactis canotia, Lym. (Pl. XIX. figs 16–18).

Ophiactis canotia, Lym., Bull. Mus. Comp. Zool., vol. vi., part 2, p. 40, pl. xiii. figs. 353–358, 1879.

Disk scales larger in centre, where primary plates may be distinguished in a rosette; no spines, or only an occasional minute one on the margin. Three or four rather long and tapering arm spines. Two mouth papillæ on each side.

(Type specimen from Station 73.) Diameter of disk 5·5 mm. Length of arm about 17 mm. Width of arm near disk 1·8 mm. Two flat, rather large, squarish mouth papillæ on each side of the narrow mouth angle, and one at the apex, similar in form to the teeth,

which are broad, heart-shaped, with a peak within. Mouth shields wider than long, broad, heart-shaped, with a rounded angle within, or wide transverse, rounded diamond-shaped. Side mouth shields rather narrow, of about equal width, meeting fully within. First under arm plate small and wider within than without; those beyond are wide shield-shaped, bounded without by a curve, on the lateral sides by re-entering curves, and within by an obtuse or truncated angle. Side mouth shields of moderate width, nearly meeting above and below, and having a well-marked spine crest. Upper arm plates broad, transverse diamond-shaped, with outer and inner angles rounded. Disk covered with rather thick overlapping scales, which are finest below, near the mouth shields, where there are about seven in the length of 1 mm. Above, the centre is occupied by a rosette of two circles of large rounded plates partially separated by a few small scales. Radial shields short, wide pear-seed shaped, separated their entire length by a narrow wedge of three scales. On interbrachial spaces below, a few minute, peg-like spines. Four short, cylindrical, tapering, blunt arm spines, all stout, especially the lower ones; upper spine longest, and about as long as one and a half joints. One large oval tentacle scale. Colour in alcohol, pale straw.

Station 73. —June 30, 1873; lat. 38° 30′ N., long. 31° 14′ W.; 1000 fathoms; globigerina ooze.

Ophiactis carnea, Ljn., Öph. Viv. Of. Kong. Akad., p. 324, 1866.
Station, Simon's Bay, Cape of Good Hope; 10 to 20 fathoms.

Ophiactis pectorale, Lym. (Pl. XXVII. figs. 4–6).

Ophiactis pectorale, Lym., Anniv. Mem. Bost. Soc. Nat. Hist., p. 10, pl. ii. figs. 26–28, 1880.

Disk without spines, and covered with thick, rounded scales, whereof the largest are near the radial shields. Two small tentacle scales.

Diameter of disk, 7 mm. Length of arm about 38 mm. Width of same, close to disk, without spines, 2 mm. Three large, flat, irregular mouth-papillæ on either side of the mouth angle; and one long, thick, blunt papilla, or tooth, at the apex. Mouth shields slightly swollen, wide diamond-shaped, with rounded angles and a slight lobe without; length to breadth, 1:1. Side mouth shields short, wide and of nearly equal width, meeting fully within. First under arm plate small, longer than wide, five-sided with rounded angles and curved outer edge; beyond, the plates are much broader than long, with an ill-marked angle within, short deep re-entering curves on the lateral sides, and outer side long and cleanly curved. Side arm plates short; narrowly separated above and below. Upper arm plates much wider than long, thick, slightly arched, with a broad rounded angle within, acute angles on the lateral sides, and outer edge gently curved. Disk thick, having deep radiating constrictions in the interbrachial spaces, extending even to the centre; it is covered with large, thick, flat, rounded, over-

lapping scales; those in the centre being much finer than those without, and the largest are arranged in rows radiating from the radial shields. These are large and stout, about as broad as long, and of an irregular triangular shape, with the outer end rounded; length to breadth 1·4 : 1·1; they are separated by a row of two or three large, rounded, overlapping scales. On the under surface the scaling is much finer than above. Four or five short, blunt, cylindrical, slightly tapering arm spines; upper one longest and somewhat longer than an arm joint. Two tentacle scales, one small and lip-like, on the under arm plate; the other oval and on the side arm plate.

Colour in alcohol, straw.

Station 214.—February 10, 1875; north-east of Celebes; lat. 4°33′ N., long. 127° 6′ E.; 500 fathoms; globigerina ooze.

This species stands nearest *Ophiactis cuspidata*, from which it differs in the scaling of the disk, and by having two tentacle scales.

Species of *Ophiactis* not herein described.

Ophiactis affinis, Duncan, Journ. Linn. Soc., vol. xiv. p. 469, pls. x. and xi. figs 23, 24, 1879.

Korean Sea.

Ophiactis ballii, Ltk., Addit. ad Hist., part 2, p. 126, 1859.

Ophiocoma Ballii, Thomp., Ann. Nat. Hist., vol. v. p. 99, 1840.
Ophiocoma Goodsiri, Fbs., Brit. Starfishes, p. 35.
Amphiura Ballii, Sars, Midd. Lit. Fauna, p. 98; Oversigt Norges Echin., p. 17.
Ophiocnida Ballii, Lym., Ill. Cat. Mus. Comp. Zool., No. i. p. 12.

North Atlantic; 40 to 50 fathoms.

Ophiactis loricata, Lym., Bull. Mus. Comp. Zool., vol. i., part 10, p. 331, 1869.
Florida; 10 to 110 fathoms.

Ophiactis lymani, Ljn., Dr. Goës, Oph. Öf. Kong. Akad., p. 629, 1871.
West Indies; 40 fathoms.

Ophiactis plana, Lym., Bull. Mus. Comp. Zool., vol. i., part 10, p. 330, 1869.
Florida; 10 to 140 fathoms.

Ophiactis virens, Sars, Midd. Lit. Fauna, p. 95, 1857; Ltk., Addit. ad Hist., part 2, p. 126; Simroth, Anatomie und Schizogonie, Zeits. für Wissen. Zoologie, vol. xxvii.; Ludwig, Echin. des Mittelmeeres, p. 548.

(?) *Ophiolepis Ballii*, Müll. & Tr., Syst. Ast., p. 97.

Mediterranean.

Ophiactis simplex, Ltk. (*Ophiolepis*), Addit. ad Hist., part 2, p. 130, 1859; Lym., Ill. Cat. Mus. Comp. Zool., No. i. p. 105.

Ophiolepis simplex, Le Conte, Proc. Phil. Acad., vol. v. p. 318, Nov. 1851.
Ophiactis Örstedii, Ltk., Addit. ad Hist., part 2, p. 129, 1859.
Ophiactis arenosa (?), Ltk., Addit. ad Hist., part 2, p. 129, 1859.

West Coast Central America.

Ophiactis arenosa, Ltk., Vid. Meddel., p. 25, March 1856; Addit. ad Hist., part 2, p. 129. Vll., Trans. Conn. Acad., vol. i., part 2, p. 266.

West Coast Central America.

Ophiactis kröyeri, Ltk., Vid., Meddel., March, 1856, p. 24; Addit. ad Hist., part 2, p. 130; Lym., Ill. Cat. Mus. Comp. Zool., No. i. p. 108; Vll., Trans. Conn. Acad., vol. i., part 2, p. 264.

Ophiolepis atacamensis, Philippi, Reise durch der Wueste Atacama, p. 190, 1860.
Ophiactis atacamensis, Ljn., Oph. Viv. Öf. Kong. Akad., p. 324, 1866.
Ophiactis fragilis, Ljn., Om några nya arter, Oph. Öf. Kong. Akad., p. 164, 1866; Oph. Viv. Öf. Kong. Akad., p. 324, 1866.

Isla Blanca, Chili; West Coast of Central America; Hawai.

Ophiactis nigrescens, Hutt., Ech. New Zealand, 1872, p. 2.

New Zealand.

Ophiactis maculosa, v. Mart., Wieg. Archiv, vol. xxxvi. p. 248, 1870.

China Sea.

Ophiactis abyssicola, Ljn., Oph. Viv. Öf. Kong. Akad., p. 324, 1866.

Amphiura abyssicola, Sars, Oversigt Norges Echin., p. 18, 1861.
Ophiocnida abyssicola, Lym., Ill. Cat. Mus. Comp. Zool., No. i. p. 12.

Norway; 190 to 400 fathoms.

Amphiura.

Amphiura, Fbs., Linn. Trans., vol. xix., 1842.

Disk small and delicate, covered with naked, overlapping scales, and furnished with uncovered radial shields. Teeth. No tooth papillæ. Mouth angles small and narrow, and bearing a few (usually four or six, rarely eight or ten) small mouth papillæ. Arms long, slender, even and more or less flattened. Arm spines short and regular. Two genital openings to each interbrachial space.

Amphiura bellis gives a good type of this generic structure. The disk wall is cased with fine, regular, overlapping scales and large, flat, elongated radial shields, having at their outer end a small knob which marks their articulation to the long, slender, flattened club-headed genital plate. To this last is fastened an equally long, slender, blade-like

scale. The three arm bones nearest the disk margin have their tops elongated outward. The tops of the mouth frames though small are considerably furrowed and grooved, but are destitute of a peristomial plate, or have only a thin lime crust. A short small jaw, universally characteristic of the genus, supports the intimately connected jaw plate and the large, flat, oblong teeth. All the species have a genital plate of the general shape just described; and the genital scale also is similar, yet varies considerably in length, sometimes being only two-thirds as long as the plate (*Amphiura concolor*); but again being continued, by slender additional pieces, quite to the mouth shield (*Amphiura angularis*). As a rule the peristomial plate is wanting, or feebly developed; nevertheless, in (*Amphiura concolor*) it is of good size, pretty thick, and divided in two pieces. (See Pl. XL. figs. 16–18.)

Table of Species of *Amphiura*.

Only two mouth papillæ on either side, whereof one is at the apex of the mouth angle.

Disk distinctly scaled on both sides.

Two tentacle scales.

Radial shields narrow, about three times as long as wide.

Radial shields broad, about twice as long as wide.

Disk scales swollen, humpy, and irregular.

Eight stout, sharp arm spines. Basal mouth papillæ spiniform,	*Amphiura crassipes.*
Ten stout, sharp arm spines. Basal mouth papilla wide and scale-like. Tentacle scales very large, one overlapping the other,	*Amphiura maxima.*
Seven flat, blunt arm spines, with rough ends. Disk scales small, but rather thick. Tentacle scales small. Upper arm plates rounded,	*Amphiura verticillata.*
Six stout, blunt arm spines, with a small beak at their ends. Disk scales delicate. Upper arm plates rounded. Tentacle scales conspicuous,	*Amphiura divaricata.*

Radial shields small, and nearly or quite separated.

Three or four tapering arm spines; the lowest but one bent, and the lowest longest,	*Amphiura complanata.*
Four straight, tapering arm spines. Disk scales delicate. Upper arm plates thin,	*Amphiura bellis.*
Six short arm spines, the lowest stoutest. Disk thin and flat. Disk scales extremely thin,	*Amphiura candida.*
Five to eight tapering, straight arm spines. Outer mouth papilla scale-like. A notch in outer side of under arm plates,	*Amphiura chiajii.*
Six stout, tapering, straight arm spines; the lowest longest, and one curved. Outer mouth papilla spiniform,	*Amphiura otteri.*
Four or five stout, short, arm spines. A rudimentary mouth papilla at outer corner of mouth slit. Disk scaling even and well marked,	*Amphiura eugeniæ.*
Four or five stout, short, arm spines. Primary plates conspicuous among the disk scaling,	*Amphiura studeri.*
Five arm spines, short, stout, and beaked; disk scaling very fine; and below, difficult to be seen,	*Amphiura palmeri.*
Seven or eight short, blunt, crowded, thick arm spines. Outer mouth papilla scale-like,	*Amphiura mediterranea.*
Similar to preceding, but lower scaling coarser; under arm plates wider, and arm spines thicker,	*Amphiura incana.*

Table of Species of *Amphiura*—continued.

Disk distinctly scaled on both sides.	One tentacle scale.	Radial shields broad, about twice as long as wide.	Seven slender arm spines; lowest longest,	*Amphiura magellanica.*
			Eight short, stout, arm spines; the upper ones flat and wide. Upper arm plates narrow,	*Amphiura capensis.*
			Five or six short, conical, barred spines. Radial shields very small. Upper arm plates narrow and rounded,	*Amphiura argentea.*
			Four or five arm spines; lowest longest and bent. Tentacle scale very large,	*Amphiura grandisquama.*
			Four or five short, blunt, nearly equal arm spines. Tentacle scale minute,	*Amphiura stimpsoni.*
			Three or four short, moderately stout arm spines. Tentacle scale minute. Radial shields and upper arm plates wider than in *Amphiura stimpsoni*,	*Amphiura acacia.*
		Radial shields narrow; about thrice as long as broad.	Six short, stout, arm spines; the middle one longest. Disk scales fine. Upper arm plates, at base of arm, as broad as long,	*Amphiura duncani.*
			Six short, stout, equal arm spines. Disk scales fine. Upper arm plates small, and about twice as broad as long,	*Amphiura constricta.*
			Four or five stumpy arm spines. Radial shields small and separated,	*Amphiura sundevalli.*
			Four or five stout, tapering, arm spines, of moderate length. Tentacle scale large and pointed,	*Amphiura josephinæ.*
			Four long, cylindrical arm spines; the uppermost and lowest longest. Tentacle scale large and rounded,	*Amphiura iris.*
	No tentacle scale.		Four tapering, equal arm spines. Disk scales rather large and spaced,	*Amphiura tomentosa.*
Disk below naked, or with rudimentary scales.	Two (sometimes one) minute tentacle scales.	Radial shields long and narrow.	Four or five stout, tapering arm spines. Under arm plates with an angle within. Upper arm plates as broad as long,	*Amphiura semiermis.*
			Five slender, tapering arm spines. Under arm plates squarish shield-shaped. Outer mouth papillæ spiniform. Upper arm plates narrow,	*Amphiura lanceolata.*
			Six tapering arm spines; lowest longest. Under arm plates squarish,	*Amphiura flexuosa.*
			Six flat, blunt arm spines; the next but one to the lowest curved and sharp,	*Amphiura latispina.*
			Five small arm spines; the one next the lowest with a terminal cross-piece,	*Amphiura kinbergi.*
	One well-marked tentacle scale.		Five tapering arm spines. Mouth shields wide,	*Amphiura glabra.*
			Four or five tapering, cylindrical arm spines. Mouth shields rounded,	*Amphiura angularis.*
	No tentacle scale.	Radial shields pear-seed shape.	Six arm spines,	*Amphiura atlantica.*
			Four to five small, widely-spaced arm spines,	*Amphiura dilatata.*
		Radial shields long and narrow.	Five short, stout arm spines. Radial shields widely diverging. Arms very long and slender,	*Amphiura perplexa.*
			Four short, stout arm spines. Radial shields small and nearly parallel. A few scales on the under surface,	*Amphiura sarsii.*
			Three or four short, arm spines; the middle one widened at its end. Radial shields strongly diverging,	*Amphiura borealis.*
			Four slender arm spines; the lowest longest; one has sometimes a cross-piece at the end. Arms very long and slender. Radial shields only slightly diverging,	*Amphiura filiformis.*

Either two or three mouth papillæ on each side.

Six arm spines,	*Amphiura anomala.*
Three arm spines,	*Amphiura lunaris.*

Table of Species of *Amphiura*—continued.

Three mouth papillæ on each side.

- Two tentacle scales.
  - The outer mouth papilla of about the same size as the second.
    - Three arm spines.
      - Radial shields short, wide, and wholly or partly joined.
        - Scales and plates thick and distinct. Tentacle scales large, ... — *Amphiura riisei.* / *Amphiura grisea.*
        - Primary plates of disk conspicuous. A few spines near edge of disk, . . . — *Amphiura antarctica.*
        - Arm spines flat and wide at the end, . . — *Amphiura planispina.*
        - Arm spines slender and pointed, . . — *Amphiura barbaræ.*
        - Radial shields very wide, and wholly joined. Mouth papillæ wide, rather irregular. Sometimes four on a side, ... — *Amphiura atra.*
      - Radial shields narrow, small, and joined.
        - Radial shields separated within; a few small spines on margin of disk, . — *Amphiura lütkeni.*
        - Edges of some of the disk scales serrated, ... — *Amphiura urtica.*
      - Radial shields, small and separated.
        - Radial shields very short, and partly buried in the disk scales, ... — *Amphiura occidentalis.*
        - Radial shields more distinct than in *Amphiura occidentalis*, and disk scales larger, . . — *Amphiura chilensis.*
        - Radial shields twice as long as broad; marginal disk scales erect and pointed. Upper arm plates broken in two, ... — *Amphiura fissa.*
    - Four arm spines.
      - Inner mouth papilla thick; two outer, small and sharp. Radial shields narrow and separated, . — *Amphiura concolor.*
    - Five arm spines.
      - Radial shields half joined. Upper arm plates wide, ... — *Amphiura örstedii.*
  - The outer mouth papilla widest
    - Radial shields short and joined.
      - Arms short, from three to eight times the diameter of the disk.
        - Three arm spines.
          - Upper arm plates about as wide as long.
            - Arm spines stout, upper one thickest. Arm $2\frac{1}{2}$ to $4\frac{1}{2}$ times diameter of disk, . — *Amphiura squamata.*
            - Arm spines slender. Disk scales large and small. Six wide arms, . . . — *Amphiura torelli.*
            - Arm spines slender. Disk scales coarser than in *Amphiura squamata*; upper arm plates longer, ... — *Amphiura tenuispina.*
            - Arms about eight times the diameter of the disk, ... — *Amphiura pugetana.*
            - Disk scales coarser, and of more varied size than in *Amphiura squamata*, . . — *Amphiura violacea.* / *Amphiura patagonica.*
            - Upper arm plates wider than in *Amphiura squamata*, . . . — *Amphiura microdiscus.*
            - A notch in the outer edge of the lower arm plates, ... — *Amphiura puntarenæ.*
          - Upper arm plates about twice as wide as long, . — *Amphiura limbata.*
        - Four arm spines, ... — *Amphiura geminata.*
      - Arms very long and slender.
        - Three arm spines, ... — *Amphiura goësi.*
    - Radial shields short and separated.
      - Disk scales fine and equal, . . . — *Amphiura kochii.*
      - Disk scales coarse and unequal, . . — *Amphiura coreæ.*
    - Radial shields long and narrow.
      - Three arm spines, ... — *Amphiura subtilis.*
      - Four or five arm spines, ... — *Amphiura gracillima.*
- One tentacle scale.
  - Radial shields long and joined.
    - Disk naked below. No primary plates distinguishable, ... — *Amphiura repens.*
    - Disk scales above and below. Primary plates conspicuous, ... — *Amphiura pulchella.*

Table of Species of *Amphiura*—continued.

No tentacle scale.

- Disk with minute scales hidden by the skin; middle spine widened at its end, ... → *Amphiura securigera.*

Four mouth papillæ on each side.

Two tentacle scales.

Three arm spines.

Radial shields long, narrow, and joined.

- Upper disk scales coarse, with primary plates conspicuous, ... → *Amphiura impressa.*
- Upper disk scales thin, fine, and equal. Disk flat, → *Amphiura lævis.*

Radial shields short, wide, and joined.

- Mouth shield long and narrow. Disk scales thick and irregular, without conspicuous primary plates, . . → *Amphiura depressa.*
- Mouth shield long heart-shaped. Upper disk scales large with conspicuous primary plates, ... → *Amphiura hastata.*
- Upper arm spine flat and broad at the end, . . . → *Amphiura integra.*
- Disk scales above and below regular and equal, with a double marginal border. Upper arm plates with a slight depression, ... → *Amphiura andreæ.*
- Mouth shields wider than long. Side mouth shields broad, → *Amphiura gibbosa.*

Radial shields separated.

- Outer mouth papilla standing on outer corner of side mouth shield, and separated from the other three, ... → *Amphiura abdita.*

Four arm spines.

- First under arm plate large and usually cut transversely in two, ... → *Amphiura duplicata.*

Five or six arm spines.

- Radial shields small and separated within, . . → *Amphiura lobata.*

One tentacle scale.

Three arm spines, middle one swelled.

- Disk scales fine; only central primary plate conspicuous. First under arm plate small, . . . → *Amphiura dalea.*
- Disk scales coarse; all primary plates conspicuous. First under arm plate wide and large, . → *Amphiura cernua.*

Four arm spines.

- Disk naked below. Tentacle scale minute and like a lip. Radial shields long and narrow, and diverging inward, . → *Amphiura glauca.*

No tentacle scales.

Four arm spines.

- Disk scaled on both sides. Radial shields large, wide, and joined for half their length. Primary plates conspicuous, ... → *Amphiura verrilli.*

Five mouth papillæ on each side.

Two tentacle scales.

- Mouth papillæ similar to *Amphiura duplicata.* Radial shields narrow and joined, ... → *Amphiura cuneata.*
- Three middle mouth papillæ longest. Point of mouth angle occupied by lowest tooth, ... → *Amphiura canescens.*
- Disk puffed, with minute crowded scales, and long, narrow, separated radial shields, ... → *Amphiura tumida.*

One tentacle scale.

- Mouth papillæ, squarish and crowded. Side mouth shields large and wide. Disk scales irregular, small and crowded, . → *Amphiura patula.*

Note.—Mr. F. W. Hutton has described *Amphiura parva* (Proc. New Zealand Institute, vol. xi. p. 305). As I have never been fortunate enough to understand any of Mr. Hutton's descriptions of Ophiurans, I should not, perhaps, have been able to place this species in the table, had I seen its diagnosis.

Amphiura maxima, Lym. (Pl. XVIII. figs. 7–9.)

Amphiura maxima, Lym., Bull. Mus. Comp. Zool., vol. vi., part 2, p. 19, pl. xi. figs. 278–281.

Disk covered on both sides with swollen, lumpy, irregular scales; ten stout, sharp arm spines. Outer mouth papillæ wide and scale like. Two very large tentacle scales, one overlapping the other.

(Type specimen from Station 188.) Diameter of disk 15 mm. Length of arm about 135 mm. Width of arm, close to disk, without spines, 2·5 mm. One very large square mouth papilla on each side of the angle, and a pair much smaller and more rounded at the apex; besides these, there may be distinguished a minute papilla outside the great flat one. Mouth shields large, and much curved within, and prolonged by a rounded lobe without. Side mouth shields very small, pear-seed shape, with the smaller end inward; they occupy the inner lateral sides of the mouth shield, and are widely separated. Under arm plates four-sided, broader than long, outer and inner edge slightly curved, and with feeble re-entering curves on the lateral sides. Side arm-plates short and high, scarcely prominent, meeting neither above nor below. Upper arm-plates small, little swollen, nearly round; but some distance out on the arm they are broader than long. Disk round, flat, and rather thick, having a notch over each arm; surface covered above and below with rather large, rounded, swollen, loosely overlapping scales, those in the interbrachial spaces being slightly larger. Radial shields pear-seed shape, little swollen, with a peak inward, separated their entire length by a row of three elongated scales, the inner one being surrounded by several much smaller. On the outer edge of the radial shields there is a row of small scales continuous with those on the margin of the disk. There are ten stout, pointed arm spines, the two lowest being about twice as long as the others, much sharper, and usually curved. Two very large flat tentacle scales with curved edges, one on the inner margin of the tentacle pore, which overlaps the one on the edge of the under arm plate. Colour in alcohol, straw.

Station 188.—September 10, 1874; lat. 9° 59′ S., long. 139° 42′ E; 28 fathoms; mud.

Amphiura bellis, Lym. (Pl. XVIII. figs. 4–6; Pl. XL. figs. 16–18).

Amphiura bellis, Lym., Bull. Mus. Comp. Zool., vol vi., part 2, p. 19, pl. xi. figs. 282–284, 1879.

Disk covered above and below with delicate scales; two tentacle scales. Radial shields narrow, about three times as long as wide; four straight tapering arm spines; upper arm plates thin.

(Type specimen from Station 232.) Diameter of disk 7 mm. Arm long, slender, and tapering gradually; its width next to the disk is 1 mm. One stout, short, blunt papilla on either side of the base of mouth-angle, and a pair, stout and bluntly pointed, at its apex. The tentacle scales of the first pair are spiniform and rather conspicuous. Mouth shields small and rounded, with sometimes a rounded angle within and a slight lobe without. Side mouth shields three-sided, quite broad without, tapering within, where they do not meet. First under arm plate six-sided and rather larger than usual; those beyond squarish, about as long as broad, with outer side nearly straight, lateral sides a little re-enteringly curved, and usually a very short truncated angle within. Side arm plates small, and not strongly projecting, meeting neither above nor below. Upper arm plates thin, of a pretty regular transverse oval shape, with lateral corners well rounded.

Disk rather thick, and slightly lobed, covered above and below with small rather thin overlapping scales, among which the primaries are scarcely to be distinguished; those near the margin and underneath are finest, being nine or ten in 1 mm. long. Radial shields long, narrow and pointed within; length to breadth 2 : ·7; they are separated their whole length by a narrow wedge composed of scales longer than those of the neighbouring disk. Four moderately stout, cylindrical, tapering arm spines, of equal lengths, and somewhat longer than the arm joints. Two minute rounded tentacle scales, one on the side arm plate, the other on the under arm plate. Colour in alcohol, very pale brown.

The young of this species has sometimes only one tentacle scale,

Station 232.—May 12, 1875; lat. 35° 11′ N., long. 139° 28′ E.; 345 fathoms; sandy mud. Station 174 (var. ?).—August 3, 1874; lat. 19° 10′ S.; long. 178° 10′ E.; 210 to 610 fathoms; globigerina ooze. Station 236.—June 5, 1875; lat. 34° 58′ N., long. 139° 30′ E.; 420 to 775 fathoms; mud.

Amphiura otteri, Ljn., Dr. Goës, Oph. Öf. Kong. Akad., p. 631, 1871.

Station 76.—July 3, 1873; lat. 38° 11′ N., long. 27° 9′ W.; 900 fathoms; globigerina ooze. Station 45.—May 3, 1873; lat. 38° 34′ N., long. 72° 10′ W.; 1240 fathoms; mud. Station 78.—July 10, 1873; lat. 37° 24′ N., long. 25° 13′ W.; 1000 fathoms; globigerina ooze. Station 50.—May 21, 1873; lat. 42° 8′ N., long. 63° 39′ W.; 1250 fathoms; grey ooze.

Ihave not much question that this is Ljungman's *Amphiura otteri* which has some variety as to size and curve of spines. The unique originals of this and many other species were, with great kindness, lent me by Professor Lovén; and Dr. G. O. Sars showed a similar generosity.

Amphiura studeri, Lym., Bull. Mus. Comp. Zool., vol. vi., part 2, p. 32, 1879.

Amphiura antarctica, Studer, Monatsb. König. Akad. Berlin, p. 461, 1876.

Station 151.—February 7, 1874; off Heard Island; 75 fathoms; mud. Off Marion Island; 50 to 75 fathoms. Station 145.—December 27, 1873; off Prince Edward's Island; lat. 46° 40′ S., long. 37° 50′ E.; 310 fathoms (young). Off Prince Edward's Island; 85 to 150 fathoms. Royal Sound, Kerguelen Island; 28 fathoms. Balfour Bay, Kerguelen Island; 20 to 60 fathoms.

As I have combined *Amphipholis* with *Amphiura*, Professor Studer's name has become a duplicate to (*Amphipholis*) *antarctica*, Ljn. I take, therefore, the liberty of giving it the name of its discoverer, who kindly identified these specimens by his own.

Amphiura incana, Lym. (Pl. XXXIII. figs 5-7; Pl. XLVI. fig. 5).

Amphiura incana, Lym., Bull. Mus. Comp. Zool., vol. vi., part 2, p. 20, pl. xi. figs. 285–287, 1879.

Disk scaled on both sides. Two tentacle scales. Radial shields narrow, about three

times as long as wide, nearly or quite separated. Lower scaling coarse. Seven or eight short, blunt, crowded, very thick arm spines.

(Type specimen from Station, Simon's Bay, Cape of Good Hope.) Diameter of disk 7 mm. Arms about 70 mm. long, and slender; close to disk their width without spines is 1·3 mm. One short wide curved papilla each side of mouth angle, and a pair, stout and bluntly pointed, at the apex of the mouth angle above; the tentacle scales of the first pair are conspicuous. Mouth shields small, of a wide diamond-shape, with outer angle truncated. Side mouth shields much longer than wide, tapering slightly within, where they nearly or quite meet; outer ends much rounded. Under arm plates nearly square, with rounded corners, and outer edge a little re-enteringly curved. Side arm plates rather thick but not prominent, meeting neither above nor below. Upper arm plates small, narrow, squarish with rounded corners; narrow within, broader without. Disk round, not very thick, covered with thin, very small overlapping scales; on the upper surface there are five or six in the length of 1 mm. Radial shields small, of a long pear-seed shape, with outer edge rounded, separated their entire length by a wedge of three rows of crowded, closely overlapping scales. Just outside the radial shields there are numerous fine scales. On the under surface of disk the scaling is much finer, there being about twelve in the length of a millimetre. Eight very short, stout, broad, nearly equal flattened arm spines; the two upper spines are somewhat broader than the others. Two minute rounded tentacle scales on the side arm plate. Colour in alcohol, pale straw.

Station, Simon's Bay, Cape of Good Hope; 10 to 20 fathoms.

A section of a portion of the disk of a male in the breeding season showed the interior quite crammed with much convoluted spermaries (Pl. XLVI. fig. 5, δ,′ δ,′ δ,′), while the bursa (δ) was crowded into a small space. Above was the thick wall of the digestive cavity pushed up against the disk roof and greatly folded (*St*). The polian vesicle (*po*), often hard to distinguish, was quite conspicuous.

Amphiura capensis, Lym. (Pl. XVIII. figs. 10–12).

Amphiura capensis, Ljn., Oph. Viv. Öf. Kong.Akad., p. 320, 1866; Dr. Goës, Oph. Öf. Kong. Akad., p. 642, 1871.

Station 141.—December 17, 1873; Lee's Point, Cape Town; lat. 34° 41′ S., long. 18° 36′ E.; 98 fathoms; sand and gravel.

Amphiura argentea, Lym. (Pl. XVI. figs. 7–10).

Amphiura argentea, Lym., Bull. Mus. Comp. Zool., vol. vi., part 2, p. 21, pl. xi. figs. 288–290, 1879.

Disk scaled on both sides. One tentacle scale. Radial shields very small; about twice as long as broad. Five or six short, conical arm spines Upper arm plates narrow and rounded.

(Type specimen from Station 171.) Diameter of disk 4 mm. Length of arm about 22 mm. Width of arm near disk 1 mm. One rather long, flat papilla on either side of the base of the small, short mouth angle, and a pair, much rounded, at apex. Scales of first pair of mouth tentacles long and rather conspicuous. Mouth shields much wider than long, rounded, with a wide curve within, and outer side feebly curved. Side mouth shields very narrow within, where they meet; wider without. First under arm plate small and narrow, being squeezed between the outer ends of the side mouth shields; those beyond are as broad as long, bounded without by a clean curve, on lateral sides by slightly re-entering curves, and within by a truncated angle. Side arm plates very short, so that there is a considerable naked space between them on the sides of the arm; they stand well out, forming a strong spine ridge. Upper arm plates narrow, longer than broad, nearly pentagonal, with rounded corners and an angle inward. Disk delicate, covered above and below with minute, thin, nearly uniform, overlapping scales; nine or ten in the length of 1 mm. where they are smallest. Radial shields very small, slightly sunken, of a pear-seed shape, nearly or quite touching without, separated within by a narrow wedge of minute scales; length to breadth ·9 : ·3. Five or six short, nearly equal, stout arm spines, whereof the lower are cylindrical and tapering, and the upper somewhat flattened and wider; lengths to that of an under arm plate, ·6, ·6, ·5, ·6, ·6, ·7, ·4. Near tip of arm there are three long, sharp, and very slender spines, twice as long as the arm joints; this so great variation of form is rare in *Amphiura*. One oval tentacle scale. Colour in alcohol, nearly white.

Station 171.—July 15, 1874; lat. 28° 33′ S., long. 177° 50′ W.; 600 fathoms.

Amphiura acacia, Lym. (Pl. XVI. figs. 15–17).

Amphiura acacia, Lym., Bull. Mus. Comp. Zool., vol. vi., part 2, p. 21, pl. xi. figs. 292–294, 1879.

Disk scaled on both sides. One minute tentacle scale. Three short, moderately stout arm spines. Radial shields short and wide.

(Type specimen from Station 235.) Diameter of disk 4·5 mm. Length of arm, about 32 mm. Width of arm near disk, 1 mm. One flat rounded papilla on each side of the mouth angle, and a pair, blunt and thicker, at the apex. Scales of the first pair of mouth tentacles flat, and low down, so as to seem nearly on a level with the outer mouth papilla. Mouth shields small, rounded, longer than broad, widest without, and having a rounded point inward. Side mouth shields three-sided, short and broad, widely separated within. Under arm plates narrow, longer than broad, five-sided, with an angle within, outer side nearly straight, and lateral sides a little re-enteringly curved. Side arm plates somewhat flaring, with a well-marked spine ridge, meeting narrowly above and barely separated below. Upper arm plates twice as broad as long, with a clean curve within and

the outer side nearly straight, but having usually a feeble lobe in the centre. Disk rather thick, covered with fine, curved, rather thin, overlapping scales, which are largest in the centre, where may be distinguished an ill-marked rosette of primary plates; those near the margin are much finer (about eight in the length of 1 mm.); on the lower surface they become thinner and near the mouth shield are hard to distinguish. Radial shields short and wide, curved on the interbrachial side, straight on the brachial; barely touching without, separated within by a narrow wedge of four or five scales: length to breadth, 1·1 : ·6. Three short, cylindrical, gently tapering, blunt, equal arm spines about ·5 mm. long. One minute, rounded tentacle scale. Colour in alcohol, pale grey.

Station 235.—June 4, 1875; lat. 34° 7′ N., long. 138° 0′ E.; 565 fathoms; mud.

Amphiura constricta, Lym. (Pl. XVI. figs. 11–14).

Amphiura constricta, Lym., Bull. Mus. Comp. Zool., vol. vi., part 2, p. 22, pl. xi. figs. 295–298, 1879.

Disk finely scaled on both sides. One tentacle scale. Radial shield narrow, about thrice as long as wide. Six short, stout arm spines. Upper arm plates narrow.

(Type specimen from Station, Port Jackson.) Diameter of disk, 5 mm. Length of arm 30 mm. Width of arm near disk, 1 mm. One minute, rounded papilla at base of mouth angle, on either side, and a pair, much larger, at the apex. Above may be seen the small scales of first mouth tentacles, which resemble the outer mouth papillæ. Mouth shields wider than long, of a three-sided or wide heart shape with rounded angles. Side mouth shields long and narrow, especially within, where they do not meet. First under arm plate small and very narrow; those beyond are small and narrow, a little longer than wide, and four-sided with rounded corners; they cover only a small portion of the under side of the arm. Side arm plates small and not projecting. Upper arm plates small and covering only a portion of the upper side; pretty regular transverse oval, about twice as broad as long. Disk thick and somewhat puffed, covered with regular, small, rounded, overlapping scales, which are somewhat larger near the centre, where small round primary plates, widely separated by smaller scales, may be distinguished; below and near margin of disk, the scaling is finer and more delicate, about ten in the length of 1 mm. Radial shields long, narrow, and slightly curved, acute within, separated their whole length by a wedge of many irregular scales of several sizes; length to breadth, 1 : ·3. Six small, short, stout blunt, peg-like, equal arm spines about ·3 mm. long, of which one or two are microscopically rough at their ends. The spines at tip of arm are similar, but proportionately longer. One rather large oval tentacle scale.

Station, Port Jackson, Australia; 2 to 10 fathoms.

Amphiura josephinæ (young ?) Ljn., Dr. Goës, Oph. Öf. Kong. Akad., p. 631, 1871.

St. Vincent, Cape Verde Islands.

Amphiura iris, Lym. (Pl. XVI. figs. 4–6).

Amphiura iris, Lym., Bull. Mus. Comp. Zool., vol. vi., part 2, p. 23, pl. xi. figs. 302–304, 1879.

Disk scaled above and below; one large oval tentacle scale; four long arm spines, the uppermost and lowest longest.

(Type specimen from Station 236.) Diameter of disk 5 mm. Width of arm without spines 1·2 mm. One short, stout, somewhat flattened blunt papilla on each side of the mouth angle, and a pair, similar, but somewhat smaller, at its apex. The large and broad scales of the first pair of tentacles are low down and conspicuous. Mouth shields of a very wide heart shape, much wider than long, with a rounded angle within. Side mouth shields thick, long, triangular, tapering inward where they do not meet. First under arm plate usually large, of a diamond shape, with its angles more or less truncated; the plates beyond are longer than wide, with outer side curved and widest, lateral sides re-enteringly curved and a truncated angle within. Side arm plates stout, and rather prominent, meeting neither above nor below. Upper arm plates fan-shaped, with inner angle more or less rounded, or truncated, and outer side gently curved. Disk covered above and below, with moderately coarse, crowded, irregular scales, those of the inter-brachial spaces being more elongated, and those on the under surface somewhat obscured by skin. Toward the centre of the disk there are seven or eight scales in the length of 1 mm. Radial shields much longer than wide, slightly curved, somewhat swollen, tapering at both ends and widest in the middle; separated their whole length by a row of three or four large scales; length to breadth, 2 : ·6. Four long, cylindrical, tapering arm spines, whereof the uppermost and lowest are longest, and equal to one and two-third arm joints. One large tentacle scale. Colour in alcohol, pale grey.

Station 236.—June 5, 1875; lat. 34° 58′ N., long. 139° 30′ E.; 420 to 775 fathoms; mud.

Amphiura tomentosa, Lym. (Pl. XXIX. figs. 10–12).

Amphiura tomentosa, Lym., Bull. Mus. Comp. Zool., vol. vi., part 2, p. 23, pl. xi. figs. 299–301, 1879.

Disk scaled on both sides with rather large, spaced scales; those below somewhat obscured by thick skin; four tapering, equal arm spines; no tentacle scale.

(Type specimen from Station, Balfour Bay, Kerguelen Island.) Diameter of disk 6·5 mm. Width of arm close to disk, without spines, 1 mm. One very small short mouth papilla, often obscured by skin, on each side of the mouth angle, and a pair, larger and rounded, at the apex. Mouth shields irregular, small, rounded triangular, with a small peak inward. Side mouth shields longer than broad, wider without than within, where they just meet; both they and the mouth shields are somewhat obscured by skin. Under arm plates narrow, longer than broad, pentagonal, with a blunt angle inward, small re-entering curves on the lateral sides, and outer lateral corners rounded.

Side arm plates moderately projecting, nearly meeting above and below. Upper arm plates somewhat broader than long, transverse oval, with a deep curve within, and a gentler one without. Disk thick and round, covered with thin, rather large, rounded scales, which are seldom overlapping, and often separated from each other by much smaller ones. Radial shields small, quite narrow, much wider without than within, where they form a sharp angle; widely separated by a wedge of three or four scales. The interbrachial space on the under surface is covered by fine scaling, which is often quite obscured near the mouth shields by skin. Four equal, rather long, stout, and bluntly-pointed arm spines. Large round tentacle pores, but no scales. Colour in alcohol, pale grey.

Station, Balfour Bay, Kerguelen Island; 20 to 60 fathoms.

Amphiura lanceolata, Lym. (Pl. XXIX. figs. 7–9).

Amphiura lanceolata, Lym., Bull. Mus. Comp. Zool., vol. vi., part 2, p. 24, pl. xi. figs. 305–307, 1879.

Disk nearly or quite naked below. Two small tentacle scales. Radial shields long and narrow. Five slender, tapering arm spines. Upper arm plates narrow. Under arm plates squarish shield shaped. Outer mouth papilla spiniform.

(Type specimen from Station 169.) Diameter of disk 4 mm. Arms long and slender, about ·7 mm. wide at the base. One slender, sharply pointed mouth papilla on each side of the mouth angle, and a pair, short and much rounded, at the apex. Mouth shield small, thick, nearly oval. Side mouth shields three sided, large and thick, as broad as long, curving round the inner angles of the mouth shield, but not meeting within. Under arm plates narrow, longer than wide, pentagonal in shape, with an obtuse, or truncated angle inward, outer edge nearly straight, and re-entering curves on the lateral sides. Side arm plates not prominent, nearly meeting above and below. Upper arm plates much rounded triangular, with angle inward. Disk flat, with deep constrictions in the interbrachial spaces. The scaling of upper surface of disk is rounded and overlapping, and is much coarser in the centre, where also the six primary plates may be distinguished: near the margin there are from eight to ten scales in the length of 1 mm. Radial shields long and narrow, sharply pointed within; joined without, where the ends are much rounded, and separated within by a wedge of five or six scales. Interbrachial space on the under surface naked, or with scattered, scarcely discernible scales. Five rather long, slender, cylindrical, tapering, equal arm spines about ·6 mm. long. Two small rounded tentacle scales, one on the under arm plate, and one on the side arm plate. Colour in alcohol, pale grey.

Station 169.—July 10, 1874; lat. 37° 34′ S., long. 179° 22′ E.; 700 fathoms; grey ooze.

Amphiura glabra, Lym. (Pl. XXXIII. figs. 8–10).

Amphiura glabra, Lym., Bull. Mus. Comp. Zool., vol. vi., part 2, p. 25, pl. xi. figs. 308–310, 1879.

Disk below naked. Mouth shields wider than long. Five stout, tapering arm spines. One tentacle scale.

(Type specimen from Station 214.) Diameter of disk 5 mm. Length of arm about 20 mm. Width of arm close to disk, without spines, ·8 mm. One stout mouth papilla in shape of an elongated cone on each side, and a pair, thick and rounded, at the apex of the mouth angle. Mouth shields broader than long, rudely triangular, with outer edges much rounded, and a small peak within. Side mouth shields small, longer than broad, wide without, tapering inward, where they do not quite meet. Under arm plates narrow, longer than broad, squarish, with re-entering curves on the lateral sides, outer corners rounded, and often an obtuse truncated angle within. Side arm plates of moderate size, and slightly flaring, meeting neither above nor below. Upper arm plates somewhat arched, rudely triangular, with outer edge rounded, and a blunt angle within; further out on the arm they become transverse oval. Disk flat and lobed, covered above with thin, rather indistinct scales; those in the centre coarser and more rounded; those in the interbrachial spaces narrower and more closely overlapping. Radial shields short pear-seed shape, longer than broad, separated their entire length by a narrow wedge row of small scales. Interbrachial spaces on the under surface naked. Five rather stout, tapering arm spines, somewhat longer than the arm joints, placed close together on the side arm plate. One rather large round tentacle scale near the inner angle of the under arm plate. Colour in alcohol, nearly white.

Station 214.—February 10, 1875; lat. 4° 33′ N., long. 127° 6′ E.; 500 fathoms; globigerina ooze.

This species is allied to *Amphiura angularis*, but has a finer build; side arm plates less prominent; side mouth shields smaller, and radial shorter and wider.

Amphiura angularis, Lym. (Pl. XXIX. figs. 1–3).

Amphiura angularis, Lym., Bull. Mus. Comp. Zool., vol. vi., part 2, p. 25, pl. xi. figs. 311–313, 1879.

Disk below naked, or with a few rudimentary scales. One well marked tentacle scale. Four or five tapering cylindrical arm spines. Mouth shields rounded.

(Type specimen from Station 150.) Diameter of disk 9 mm. Length of arm 45 mm. Width of arm, without spines, close to disk, 1·2 mm. One long, tapering, pointed mouth papilla on each side, and a pair, short, blunt, and much rounded, at the apex of the mouth angle. The tentacle scale of the first pair is large and spiniform. Mouth shields rather large, nearly circular, with a small peak within. Side mouth shields large, three-sided, broad without, and curving downward about the mouth shield, narrow and

separated within. First under arm plate very small and squarish; those beyond are nearly square and rather narrow, with outer corners rounded, and slight re-entering curves on the lateral sides. Side arm plates wide, prominent, and much swollen along the spine crest; separated below, nearly or quite meeting above. Upper arm plates transverse oval, much wider than long, with well rounded lateral ends. Disk flat and angular, covered above with coarse, rounded, overlapping scales, the five primaries being but little larger than the other scales; the scaling on the interbrachial spaces is finer than in the central portion. Radial shields much longer than broad, tapering towards each extremity, with the inner point acute, separated their entire length by two or three rows of irregular scales; length to breadth, 2 : ·7. The scales of the margin continue round the outer end of the radial shields. Interbrachial space below only about one-third covered with minute scaling; the rest of the space is naked. Four stout, blunt, tapering, cylindrical arm spines, evenly spaced on the side arm plate. One stout, round tentacle scale on the inner side of the tentacle pore. Colour in alcohol, disk grey, arms straw.

Station 150.—February 2, 1874; lat. 52° 4′ S., long. 71° 22′ E.; 150 fathoms; rock.

Amphiura dilatata, Lym. (Pl. XXIX. figs. 4–6).

Amphiura dilatata, Lym., Bull. Mus. Comp Zool., vol. vi., part 2, p. 26, pl. xi. figs. 314–316, 1879.

Disk naked below. Radial shields narrow pear-seed shape. Four or five small, widely spaced arm spines. No tentacle scales.

(Type specimen from Station 141.) Diameter of disk 5 mm. Length of arm 23 mm. Width of same without spines, close to the disk, ·7 mm. At the base of the mouth angle, on each side, is a long, very slender mouth papilla, and a pair, blunt and rounded, at the apex. Mouth shields small, short diamond shape, with much rounded angles. Side mouth shields small and curved, narrow within, where they nearly or quite meet; outer end wide club-shaped. Under arm plates narrow, longer than broad, squarish, with re-entering curves on the lateral sides, and the outer edge nearly straight. Side arm plates very small, not prominent, nearly or quite meeting above, separated below. Upper arm plates transverse oval, with the inner curve stronger than the outer, and the lateral corners pointed; there is a slight longitudinal ridge. Disk rather thick and slightly puffed; primary plates widely separated and scarcely to be distinguished from the general scaling, which is fine, regular and overlapping, having about ten scales in the length of 1 mm.; those of the interbrachial spaces are smallest and most closely overlapping. Radial shields small, and slightly swollen, narrow pear-seed shaped, separated their entire length by a narrow wedge row of scales; a pair of short, stout scales at their outer ends. Under surface of disk naked. Five short, tapering, blunt arm spines, evenly spaced on the side

arm plate, and standing at right angles to the arm; the middle spine is stoutest. Large tentacle pores, but no tentacle scales. Colour in alcohol, disk grey, arms straw.

Station 141.—December 17, 1873; lat. 34° 41′ S., long. 18° 36′ E.; 98 fathoms; sand and gravel.

Amphiura squamata, Sars. *Ophiolepis* (*Amphiura*) *squamata*, Sars, Mid. Lit. Fauna, p. 84, 1857; Lym., Ill. Cat. Mus. Comp. Zool., No. i. p. 121; Ludwig, Echin. des Mittelmeeres, p. 549.

Ophiura elegans (?), Leach, Zool. Misc., vol. ii. p. 59, 1815.
Asterias squamata, Delle Chiaje, Mem., vol. iii. p. 77, 1828.
Ophiura neglecta, Johnston, Mag. Nat. Hist., p. 467, 1835.
Ophiolepis squamata, Müll. & Tr., Wieg. Archiv, vol. vi. p. 328; Syst. Ast., p. 92.
Ophiocoma neglecta, Fbs., Brit. Starfishes, p. 30.
Ophiolepis tenuis, Ayr., Proc. Bost. Soc. Nat. Hist., vol. iv. p. 133, 1851.
Amphiura tenuis, Lym., Proc. Bost. Soc. Nat. Hist., vol. vii. p. 194.
Amphiura elegans, Norm., Biology "Valorous" Cruise, Proc. Roy. Soc. Lond., vol. xxv. p. 215.
Ophiura moniliformis, Grube, Aktin. Echin. u. Wür., p. 18, 1840.
Amphipholis elegans, Ltk., Vid. Meddel., p. 140, 1871.
Amphipholis kinbergi, Ljn., Dr. Goës, Oph. Öf. Kong. Akad., p. 646, 1871.
Amphipholis appressa, Ljn., Dr. Goës, Oph. Öf. Kong. Akad., p. 647, 1871.
Amphiura tenera, Ltk., Addit. ad Hist., part. 2, p. 124, pl. iii., 1859; Lym., Ill. Cat. Mus. Comp. Zool., No. i. p. 123.
Amphipholis lineata, Ljn., Dr. Goës, Oph. Öf. Kong. Akad., p. 634, 1871.

Menschnikoff[1] describes a curious low worm, *Rhopalura* of the family *Orthonectidæ*, whose cysts sometimes fill the body cavity of *Amphiura squamata*, and take the place of ovaries, which disappear. I have never encountered this parasite.

Station 141.—December 17, 1873; lat. 34° 41′ S., long. 18° 36′ E.; 98 fathoms; sand and gravel. Station 163.—April 4, 1874; lat. 36° 56′ S., long. 150° 30′ E.; 120 fathoms. Such diverse localities further prove the cosmopolite nature of this species.

Amphiura duplicata, Lym. (Pl. XVII. figs. 10–12).

Amphiura duplicata, Lym., Ill. Cat. Mus. Comp. Zool., No. viii., part 2, p. 19, pl. v. fig. 78, Outline fig. 87; Bull. Mus. Comp. Zool., vol. v., part 9, p. 226.

Station 56.—May 29, 1873; off Bermudas; 1075 fathoms; grey ooze.

Quite common in less depths throughout the West Indies. *Amphiura duplicata* is somewhat variable; and, especially, the first under arm plate is not always broken in two. Numerous specimens from the second "Blake" Expedition show usually only three arm spines; three and often four irregular mouth papillæ on each side, and disk scales varying in thickness.

[1] Zeitschr. f. Weissen. Zool., vol. liii. part 2, p. 282, 1881.

Amphiura concolor, Lym. (Pl. XVII. figs. 1–3).

Amphiura concolor, Lym., Bull. Mus. Comp. Zool., vol. vi., part 2, p. 27, pl. xii. figs. 317–319, 1879.

Three mouth papillæ on each side, the inner one large and thick, the two outer small and bead-like. Two, sometimes only one, small tentacle scales. Four arm spines. Radial shields narrow and separated.

(Type specimen from Station 195.) Diameter of disk 8 mm. Length of arm 65 mm. Width of arm close to disk, without spines, 1 mm. Two very short, small mouth papillæ each side of the mouth angle, and a pair, large, rounded, much swollen at its apex. Four large, thick teeth, with a square cutting edge. Mouth shield wide spear-head shaped, with a blunt angle within, and the inner sides slightly curved. Side mouth shields large, broad without, tapering inward, where they just meet. Basal under arm plates large, pentagonal with the inner angle truncated, broader than long, outer edge straight, lateral sides re-enteringly curved. Side arm plates rather small, projecting moderately, meeting neither above nor below. Upper arm plates short and wide, of a transverse pointed oval form, with outer and inner edge slightly curved. Disk round and flat, but rather thick, covered with irregular, overlapping scales; those in the interbrachial spaces being somewhat coarser than the others. Radial shields long and narrow, with outer end rounded, and an acute angle inward, separated their entire length by a single row of scales. Interbrachial spaces on the under surface covered by similar, but finer, scaling. Four short, blunt, rather slender arm spines, the upper one being slightly shortest. Two small, rounded tentacle scales, one on the brachial side of the tentacle pore and one on the side arm plate. On some pores there is but a single scale. Colour in alcohol, straw.

Station 195.—October 3, 1874; lat. 4° 21′ S., long. 129° 7′ E.; 1425 fathoms; grey ooze. Station 191.—September 23, 1874; lat. 5° 41′ S., long. 134° 4′ E.; 800 fathoms; mud.

Amphiura depressa (?), Lym.

Amphipholis depressa, Ljn., Oph. Viv. Öf. Kong. Akad., p. 312, 1866; Ltk., Oph. Nov. Descr. pls. i. and ii. figs. 2*a*, 2*b*.

I put a query to this species, though I am nearly sure of its identity.

Station 233*b*.—May 26, 1875; lat. 34° 20′ N., long. 133° 35′; 15 fathoms; mud. Fiji Islands; 6 fathoms.

Amphiura dalea, Lym. (Pl. XVIII. figs. 11–13).

Amphiura dalea, Lym., Bull. Mus. Comp. Zool., vol. vi., part 2, p. 27, pl. xii. figs. 320–322, 1879.

Four mouth papillæ on a side. Three arm spines, the middle one swollen. One tentacle scale. Disk scales fine, only the central primary plate being conspicuous. First under arm plate small.

(Type specimen from Station 325.) Diameter of disk 9 mm. Width of arm close to disk, without spines, 1·3 mm. Three stout, close-set papillæ on either side of the mouth angle, and two large and much rounded at the apex; of those on the sides the outermost is largest. Mouth shields small, triangular, a little longer than wide, rounded on all sides except within, where is a point. Side mouth shields large, broad without, tapering inward where they just meet. First under arm plate very small; those beyond are broader than long, angular, and with re-entering curves on the sides where are the tentacle pores; still farther out they are triangular, with outer edge much curved, and a truncated angle within. Side arm plates short, not much projecting, meeting above beyond the first upper arm plate, and below beyond the seventh or eighth. Upper arm plates slightly swollen, very short and wide, of a transverse oval shape, and with a small longitudinal ridge. Disk flat and tolerably thick, covered with thin, small, flat, overlapping scales, with one somewhat larger, rounded primary in the centre; about four scales in the length of 1 mm. Radial shields long and broad, bluntly pointed within, nearly or quite separated their entire length by a narrow wedge of scales. On the interbrachial spaces on the under surface the scaling is much finer than that above, there being about fifteen in the length of 1 mm. Three tapering, rather sharp arm spines, the upper one being shorter than the other two, and the middle one much the stoutest, and swollen. One small longer than broad tentacle scale on the brachial side of the tentacle pore; a little way out on the arm there usually is no tentacle scale. Colour in alcohol pale straw.

Station 325.—March 2, 1876; lat. 36° 44′ S., long. 46° 16′ W.; 2650 fathoms; grey mud.

Amphiura cernua, Lym. (Pl. XVII. figs. 13–15).

Amphiura cernua, Lym., Bull. Mus. Comp. Zool., vol. vi., part 2, p. 28, pl. xii. figs. 323–325, 1879.

Four mouth papillæ on each side. One tentacle scale. Three arm spines, the middle one swelled. Disk scales coarse; all primary plates conspicuous. First under arm plate wide and large.

(Type specimen from Station 241.) Diameter of disk 5·7 mm. Length of arm about 24 mm. Width close to disk, without spines ·7 mm. Four mouth papillæ on each side, of which three are short and blunt (the inner one being more pointed), and two at the apex of the mouth angle are larger and more swollen. Mouth shields small, flat, triangular, with a blunt angle inward and outer edge curved. Side mouth shields broad without, and tapering inward, where they just meet. Under arm plates large, with a long angle within and slight re-entering curves on the lateral sides. Side arm plates slightly swollen, meeting below some distance out on the arm, and above beyond the first upper arm plate. Upper arm plates transverse oval, slightly swollen, with

outer and inner edges much curved. Disk flat and slightly angular, covered with thin, semicircular, overlapping scales, the six primary plates being much the largest; the scaling in the interbrachial spaces is somewhat coarser than on the rest of the disk. Radial shields very large and broad, somewhat longer than wide, of a blunt pear-seed shape; joined without, separated within by a wedge of two small scales. On the under surface the interbrachial space is covered with very minute scaling. One large tentacle scale longer than broad. Three short arm spines, the upper one longest and slender, while the middle one is strongly swollen at its base. Colour in alcohol, straw.

Station 241.—June 23, 1875; lat. 35° 41′ N., long. 157° 42′ E.; 2300 fathoms; red clay.

Amphiura glauca, Lym. (Pl. XVIII. figs. 1–3).

Amphiura glauca, Lym., Bull Mus. Comp. Zool., vol. vi., pt. 2, p. 29, pl. xii. figs. 326–328, 1879.

Four mouth papillæ on each side. One tentacle scale minute and like a lip. Four slender arm spines. Radial shields long and narrow, and diverging inward. Disk naked below.

(Type specimen from Station 232.) Diameter of disk 5·5 mm. Width of arm close to disk 1 mm. Four short pointed mouth papillæ on each side of the mouth angle, of which that at the apex is much the largest and most rounded. Mouth shield small, with a rounded angle inward, and outer edge curved. Side mouth shields small, long, triangular, somewhat curved, just meeting within. Under arm plates small, longer than wide, with re-entering curves on the lateral sides, outer corners rounded and a truncated angle within. Side arm plates small and little projecting, meeting neither above nor below, till some distance out on the arm. Upper arm plates small, a little broader than long, bounded within by a deep curve, and without by a gentler one, having a small ridge in the centre, which forms a continuous line along the arm. Disk rather thick, naked below, but covered above with very minute rounded scales, about seven in the length of 1 mm. where they are finest. Radial shields long and very narrow, tapering inward to a blunt point; they are joined without, and separated within by several small scales. Four slender tapering arm spines, the upper and under being usually somewhat longer than the two in the middle. One very small lip-like tentacle scale, on the inner side of the tentacle pore. Colour in alcohol, dull grey.

Station 232.—May 12, 1875; lat. 35° 11′ N., long. 139° 28′ E.; 345 fathoms; sandy mud. Station 236.—June 5, 1875; lat. 34° 7′ N., long. 138° 0′ E.; 420 fathoms; mud.

Amphiura verrilli, Lym. (Pl. XVII. figs. 16–18).

Amphiura verrilli, Lym., Bull. Mus. Comp. Zool., vol. vi., pt. 2, p. 29, pl. xii. figs. 329–331, 1879.

Four mouth papillæ on each side. Four arm spines. No tentacle scales. Radial shields large and wide, and joined for half their length.

(Type specimen from Station 54.) Diameter of disk 6 mm. Width of arm, without spines, close to disk, 1 mm. Four short, blunt mouth papillæ on each side, the two at the apex being largest and conical; between them may be seen the lowest tooth, having a broken edge. Mouth shields small, rounded, with a slight angle within. Side mouth shields large, narrow within, where they meet; broader without, where they curve partially round the mouth shield. First under arm plate very small; those beyond are swollen, narrow, longer than broad, having the outer edge much rounded, deep re-entering curves on the lateral sides, and a short, straight side within. Side arm plates small, separated below, but just meeting above. Upper arm plates much broader than long, transverse oval, with the inner edge nearly straight, outer edge curved, and blunt angles on the lateral sides. Disk flat, moderately thick and slightly angular, covered with small, thin, irregular, overlapping scales; there are six large, widely separated primary plates, one round one in the centre, surrounded by five others broader than long. Radial shields large, longer than wide, of an elongated pear-seed shape, their pointed inner ends being separated by two small, angular scales. Interbrachial space on the under surface covered by fine overlapping scales, smaller than those above. Four arm spines standing close together on the side arm plates; they are about as long as an arm joint, and rather slender and tapering except the one next the lowest, which is strongly swollen at the base. Large round pores, but no tentacle scales. Colour, grey.

Station 54.—May 27, 1873; lat. 34° 51′ N., long. 63° 59′ W.; 2650 fathoms; grey ooze.

Amphiura canescens, Lym. (Pl. XVII. figs. 7–9).

Amphiura canescens, Lym., Bull. Mus. Comp. Zool., vol. vi., part 2, p. 30, pl. xii. figs. 332–334, 1879.

Five mouth papillæ on each side, of which the three middle ones are longest; point of mouth angle occupied by the lowest tooth. Two tentacle scales. Three arm spines about as long as a joint.

(Type specimen from Station 171.) Diameter of disk 5 mm. Arms long and slender. Width of arm, close to disk, without spines, 1 mm. Five stout, blunt mouth papillæ on either side of the mouth angle, the three middle ones being longer, broader, and more flattened than the rest. One large, triangular papilla, or tooth, at apex of jaw. Mouth shields broad triangular, with blunt angles and outer edge much rounded. Side mouth shields long and narrow, but slightly swollen, broader without than within, where they just meet. First under arm plate small, pentagonal, with an angle inward and slightly re-entering curves on the lateral sides; the other basal plates are large, with outer edge curved, and wider than the inner, and with lateral sides re-enteringly curved. Side arm plates not prominent, meeting neither above nor below at the base

of the arm. Upper arm plates broader than long, transverse oval, with lateral ends slightly pointed. Disk flat, but rather thick, its upper surface covered with small, slightly swollen, irregularly shaped, overlapping scales, about five in the length of 1 mm. where they are coarsest. Radial shields blunt pear-seed shaped, slightly pointed within, separated by one large and several small scales. Interbrachial spaces on the under surface covered by the same kind of scaling. Three stout, tapering, bluntly-pointed arm spines, about as long as a joint, the lowest slightly longer than the others, placed close together on the side arm plate. Two tentacle scales, the one on the brachial side small and narrow, the interbrachial one much larger, with wide, rounded edge. Colour in alcohol, nearly white.

Station 171.—July 15, 1874; lat. 28° 33′ S., long. 177° 50′ W.; 600 fathoms; rock.

Amphiura patula, Lym. (Pl. XVII. figs. 4–6).

Amphiura patula, Lym., Bull. Mus. Comp. Zool., vol. vi., part 2, p. 31, pl. xii. figs. 335–337, 1879.

Five (sometimes only four) mouth papillæ on each side. One tentacle scale. Mouth papillæ squarish and crowded. Side mouth shields large and wide. Disk scales small, irregular, and crowded.

(Type specimen from Station 156.) Diameter of disk 14·5 mm. Width of arm close to disk, without spines, 2 mm. Five (sometimes only four) squarish, crowded mouth papillæ on either side, whereof the outermost and innermost are largest; besides these there is an odd one at the centre of the apex. Mouth shields small, rounded triangular, with a blunt angle inward. Side mouth shields short and stout, rudely triangular in shape, the inner angles not quite meeting at the apex of the mouth shield. Under arm plates pentagonal, with inner angle sometimes truncated, outer edge slightly rounded, and small re-entering curves on the lateral sides. Side arm plates narrow, bent, not very prominent, meeting above, but just separated below. Upper arm plates much broader than long, transverse oval, with outer and inner edges gently curved. Disk flat, covered with thin, flat, irregular, crowded scales, among which six small widely separated primary plates are with difficulty distinguishable. Radial shields large and broad, of a wide pear-seed shape, separated their entire length by a narrow wedge of three or four scales. On the under surface the scales are much finer and more rounded. Three short, round, bluntly tapering arm spines, the middle one larger than the others but not so long as an arm joint, and all placed low on the side arm plate. Only one longer than wide, somewhat swollen tentacle scale, on the brachial side of the tentacle pore.

Except that it has usually five, instead of four, mouth papillæ on a side, this species stands related to *Amphiura dalea*, from which it is distinguished by smaller arm spines,

different under arm plates, and coarser, more irregular scaling. Colour in alcohol, greyish.

Station 156.—February 26, 1874; lat. 62° 26′ S., long., 95° 44′ E.; 1975 fathoms; diatom ooze.

Species of *Amphiura* not herein described.

Amphiura crassipes, Ljn., Oph. Viv. Öf. Kong. Akad., p. 319, 1866; Dr. Goës, Oph. Öf. Kong. Akad., p. 642, 1871.

Atlantic, off Rio de Janeiro; 45 fathoms.

Amphiura verticillata, Ljn., Oph. Viv. Öf. Kong. Akad., p. 320, 1866.

Galapagos Island.

Amphiura divaricata, Ljn., Oph. Viv. Öf. Kong. Akad., p. 318, 1866.

Between Batavia and Singapore.

Amphiura complanata, Ljn., Oph. Viv. Öf. Kong. Akad., p. 319, 1866; Dr. Goës, Oph. Öf. Kong. Akad., p. 642, 1871.

Atlantic, off Rio de Janeiro.

Amphiura candida, Ljn., Oph. Viv. Öf. Kong, Akad., p. 318, 1866.

Mozambique.

Amphiura chiajei, Fbs., Linn. Trans., vol. xix. p. 151, 1843; Sars, Mid. Lit. Fauna, p. 86; Ltk., Addit. ad Hist., part 1, p. 57, pl. ii. figs. 12 *a*, *b*; Lym., Ill. Cat. Mus. Comp. Zool., part 1, p. 19; Ludwig, Echin. des Mittelmeeres, p. 550.

Asterias filiformis, Delle Chiaje (non O. F. Müller), Mem., vol. ii. p. 359, 1825.
Amphiura florifera (?), Fbs., Linn. Trans., p. 150, 1845.
Amphiura Stepanovii, Tscherniawsky, Protocol. d. Moskauer Naturfor. Versam., 1869.

Black Sea; North European Seas; Mediterranean; 40 to 120 fathoms.

Amphiura mediterranea, Lym.

Amphiura chiajei (pars).

This is the common littoral form of the Mediterranean. It is distinguished by numerous short, blunt, crowded arm spines. Thus an animal with a disk only 4·5 mm. in diameter had seven arm spines; with a disk of 5 mm., six to eight spines; and with a disk of 6 mm., eight to nine spines. Whereas the northern, or Scandinavian form had these proportions: disk 6·3 mm., five tapering spines; disk, 8 mm., six spines; disk,

10 mm. six to seven spines. The figure of the original *Amphiura chiajei* (Fbs. *loc. cit.*) agrees well with this northern form, except in having a large central rosette of primary plates.

Amphiura eugeniæ, Ljn., Oph. Viv. Öf. Kong. Akad., p. 318, 1866; Dr. Goës, Oph. Öf. Kong. Akad., p. 642, 1871; Lym., Ill. Cat. Mus. Comp. Zool., No. viii., part 2, p. 5.

Atlantic, off Rio La Plata; 30 to 55 fathoms.

Amphiura palmeri, Lym.

Amphiura flexuosa (?), Lym., Ill. Cat. Mus. Comp. Zool., No. viii., part 2, p. 17, pl. iii. figs. 35–37, pl. v. fig. 68, 1875.

West Indies; 100 fathoms.

Amphiura magellanica, Ljn., Oph. Viv. Öf. Kong. Akad., p. 320, 1866; Lym., Ill. Cat. Mus. Comp. Zool. (same sp. ?). No. viii., part 2, p. 19.

Straits of Magellan; North-east Patagonia; 30 fathoms.

Amphiura grandisquama, Lym., Bull. Mus. Comp. Zool., vol. i., part 10, p. 334, 1869; Bull. Mus. Comp., vol. v., part 9, p. 226.

West Indies; 10 to 240 fathoms.

Amphiura stimpsoni, Ltk., Addit. ad Hist., part 2, p. 116, 1859.

West Indies; Cape Frio, Brazil; 10 to 35 fathoms.

Amphiura duncani, Lym.

Amphiura Lütkeni, Duncan, Journ. Linn. Soc., vol. xiv., p. 464, pl. x. fig. 17, 1879.

Korean Sea.

Amphiura sundevalli, Ljn., Oph. Viv. Öf. Kong. Akad., p. 320, 1866.

Ophiolepis Sundevalli, Müll. & Tr., Syst. Ast., p. 93, 1842.

Amphiura Holbölli, Ltk., Vid. Meddel., Nov. 1854, p. 98; Addit. ad Hist., part 1, p. 55, pl. ii. figs. 13 *a*, *b*; Lym., Ill. Cat. Mus. Comp. Zool. No. i. p. 118.

European Arctic Sea; Greenland; 15 to 50 fathoms.

Amphiura semiermis, Lym., Bull. Mus. Comp. Zool., vol. i., part 10, p. 332, 1869; Bull. Mus. Comp. Zool., vol. v., part 9, p. 227.

West Indies; 377 to 539 fathoms.

Amphiura flexuosa, Ljn., Oph. Viv. Öf. Kong. Akad., p. 319, 1866; Non *Amphiura flexuosa*, Lym., Ill. Cat. Mus. Comp. Zool., No. viii., part 2, p. 17.
Brazil.

Amphiura latispina, Ljn., Oph. Viv. Öf. Kong. Akad., p. 320, 1866.
Atlantic, off Rio La Plata.

Amphiura kinbergi, Ljn., Dr. Goës, Oph. Öf. Kong. Acad., p. 643, 1871.
South Brazil.

Amphiura atlantica, Ljn., Oph. Viv. Öf. Kong. Akad., p. 321, 1866.
Near St. Helena.

Amphiura perplexa, Lym., Ill. Cat. Mus. Comp. Zool., No. i. p. 12, 1865.
Ophiolepis perplexa, Stimp., Proc. Phil. Acad., vol. vii. p. 386, 1854.
Port Jackson.

Amphiura sarsi, Ljn., Dr. Goës, Oph. Öf. Kong. Akad., p. 630, 1871.
Azores; 30–600 fathoms.

Amphiura filiformis, Fbs., Trans. Linn. Soc., vol. xix. p. 151, 1843; Ltk., Addit. ad Hist., part 1, p. 56, pl. vol. ii. figs. 11 *a*, *b*; Lym., Ill. Cat. Mus. Comp. Zool., No. i. p. 116. Ljn. Oph. Viv. Öf. Kong. Akad., p. 321, 1866; Ludwig, Echin. des Mittelmeeres, p. 549.
Asterias filiformis, O. F. Müller, Zool. Dan. Prodr., p. 235, 1776.
Ophiura filiformis, Lmk., Hist. Anim. sans Vert., vol. ii. p. 546.
Ophiocoma filiformis, Fbs., Brit. Starfishes, p. 40.
Ophiolepis filiformis, Müll. & Tr., Syst. Ast., p. 94.
North European Seas; 8 to 100 fathoms.

Amphiura borealis, Lym.
Ophiopelta borealis, G. O. Sars, Nye Echin. Vid. Selsk. Forh., p. 16, 1871.
Lofoten Island; 80 to 400 fathoms.

Amphiura anomala, Lym., Ill. Cat. Mus. Comp. Zool., No. viii., part 2, p. 15, pl. iii. figs. 26 to 28.
Juan Fernandez; 220 fathoms.

Amphiura lunaris, Lym., Bull. Mus. Comp. Zool., vol. v., part 9, p. 226, pl. ii. figs. 31–33, 1878.
West Indies; 955 fathoms

Amphiura torelli, Lym.

Amphipholis torelli, Ljn., Dr. Goës, Oph. Öf. Kong. Akad., p. 645, 1871.

Iceland.

Amphiura tenuispina, Ljn., Tillägg Skan. Oph. Öf. Kong. Akad., p. 360, 1864.

Amphiura squamata (var. ?), Ljn., Oph. Viv. Öf. Kong. Akad., p. 313, 1866.
Amphipholis tenuispina, Ljn., Dr. Goës, Oph. Öf. Kong. Akad., p. 633, 1871.

Norway; 60 to 300 fathoms.

Amphiura pugetana, Lym., Proc. Bost. Soc. Nat. Hist., vol. vii. p. 193, 1868; Ill. Cat. Mus. Comp. Zool., No. i. p. 125.

Puget Sound; Mendocino, Cal.

Amphiura violacea, Örd. & Ltk., Vid. Meddel., March 1856, p. 26; Addit. ad Hist., part 2, p. 123; Vll., Trans. Conn. Acad., vol. i., part 2, p. 261.

West Coast of Central America.

Amphiura patagonica, Lym.

Amphipholis patagonica, Ljn., Dr. Goës, Oph. Öf. Kong. Akad., p. 646, 1871.

Straits of Magellan.

Amphiura microdiscus, Örd. & Ltk., Vid. Meddel., March, 1856, p. 26; Ltk., Addit. ad Hist., part 2, p. 123; Vll., Trans. Conn. Acad., vol. i., part 2, p. 261.

West Coast of Central America; 10 fathoms.

Amphiura puntarenæ, Örd. & Ltk., Vid. Meddel., 1856, p. 25; Addit. ad Hist., part 2, p. 123; Vll., Trans. Conn. Acad., vol. i., part 2, p. 261.

West Coast of Central America; 3 fathoms.

Amphiura limbata, Ltk., Addit. ad Hist., part 2, p. 115.

Ophiolepis limbata, Grube, Acad. Cæs. Leop. Nova Acta, vol. xxvii. p. 34, 1860.

Rio de Janeiro.

Amphiura geminata, Ltk., Addit. ad Hist., part 2, p. 122.

Ophiolepis geminata, Le Conte, Proc. Phil. Acad., vol. v. p. 317, 1851; Vll., Trans. Conn. Acad., vol. i., part 2, p. 261.

West Coast Central America.

Amphiura goësii, Lym.

Amphipolis Goësii, Ljn., Dr. Goës, Oph. Öf. Kong. Akad., p. 635, 1871.

West Indies; 280 fathoms.

Amphiura kochii, Lym.

Amphipholis kochii, Ltk., Oph. Nov. Deser., p. 107, pls. i. and ii. figs. 1*a*, 1*b*, 1872.

Manchuria.

Amphiura coreæ, Duncan, Journ. Linn. Soc., vol. xiv. p. 466, pl. x. figs. 18, 19, 1879.

Korean Straits; 37 fathoms.

Amphiura subtilis, Lym.

Amphipholis subtilis, Ljn., Oph. Viv. Öf. Kong. Akad., p. 314, 1866.

Rio de Janeiro.

Amphiura gracillima, Ltk., Addit. ad Hist., part 2, p. 114.

Ophiolepis gracillima, Stimp., Proc. Bost. Soc. Nat. Hist., vol. iv. p. 224, 1852.
Amphiura Januarii, Ljn., Om några nya arter, Öf. Kong. Akad., p. 165, 1866.

South Carolina.

Amphiura riisei, Ltk., Proc. Bost. Soc. Nat. Hist., vol. vii. p. 258, 1860.

Amphiura cordifera, Ltk. (non *Asterias*, Bosc), Addit. ad Hist., part 2, p. 120, pl. iii. fig. 2, 1859.

West Indies.

Amphiura grisea, Lym.

Amphipholis grisea, Ljn., Oph. Viv. Öf. Kong. Akad., p. 313, 1866.

Gulf of Guayaquil.

Amphiura antarctica, Lym.

Ophiophragmus antarcticus, Ljn., Oph. Viv. Öf. Kong. Akad., p. 315, 1866.
Amphipholis antarctica, Ljn., Dr. Goës. Oph. Öf. Kong. Akad., p. 649, 1871.

Straits of Magellan.

Amphiura planispina, Lym., Bull. Mus. Comp. Zool., vol. iii., part 10, p. 228, 1874.

Amphipholis planispina, V. Mart., Monatsb. König. Akad. Berlin, p. 347, 1867.

Rio de Janeiro.

Amphiura barbaræ, Lym., Ill. Cat. Mus. Comp. Zool., No. viii., part 2, p. 17, pl. iii. figs. 32, 54.

Santa Barbara, California ; 22 fathoms.

Amphiura atra, Ltk., Addit. ad Hist., part 2, p. 118, 1859.

Ophiolepis atra, Stimp., Proc. Bost. Soc. Nat. Hist., vol. iv. p. 225, 1852.

South Carolina.

Amphiura lütkeni, Lym.

Amphipholis lütkeni, Ljn., Dr. Goës, Oph. Öf. Kong. Akad., p. 636, 1871.

West Indies ; 10 fathoms.

Amphiura urtica, Lym., Proc. Bost. Soc. Nat. Hist., vol. vii. p. 195, 1860 ; Ill. Cat. Mus. Comp. Zool., No. i. p. 128.

Puget Sound.

Amphiura occidentalis, Lym., Proc. Bost. Soc. Nat. Hist., vol. vii. p. 194, 1860 ; Ill. Cat. Mus. Comp. Zool., No. i. p. 130, figs. 12, 13.

Monterey, Cal., to Puget Sound.

Amphiura chilensis, Ltk., Addit. ad Hist., part 2, p. 122, 1859.

Ophiolepis chilensis, Mull. & Tr., Wieg. Archiv, vol. ix. p. 120, 1843 ; Lym., Ill. Cat. Mus. Comp. Zool., No. viii., part 2, p. v., fig. 77, 1875.

Chili ; 3 fathoms.

Amphiura fissa, Ltk., Addit. ad Hist., part 3, p. 30, 1869.

Amoor.

Amphiura örstedii, Ltk., Vid. Meddel., March, 1856, p. 26 ; Addit., ad Hist., part 2, p. 121, 1859.

West Coast of Central America ; 3 fathoms.

Amphiura repens, Lym., Ill. Cat. Mus. Comp. Zool., No. viii., part 2, p. 18, pl. iii. figs. 38–40.

West Coast of Florida ; 14 fathoms.

Amphiura pulchella, Lym., Bull. Mus. Comp. Zool., vol. i., part 10, p. 337, 1869.

Florida ; 18 to 39 fathoms.

Amphiura securigera, Lym.

Ophiopelta securigera, Düb. & Kor., Öf. Kong. Akad., p. 236, 1844; Ljn., Oph. Viv. Öf. Kong. Akad., p. 321, 1866.

Baltic Sea.

Amphiura impressa, Lym.

Amphipholis impressa, Ljn., Oph. Viv. Öf. Kong. Akad., p. 314, 1866.

Between Batavia and Singapore.

Amphiura lævis, Lym., Bull. Mus. Comp. Zool., vol. iii., part 10, p. 229, pl. iv. figs. 18–21, 1874.

Philippines.

Amphiura hastata, Lym.

Amphipholis hastata, Ljn., Oph. Viv. Öf. Kong. Akad., p. 313, 1866.

Mozambique.

Amphiura integra, Lym.

Amphipholis integra, Ljn., Oph. Viv. Öf. Kong. Akad., p. 313, 1866.

Port Natal, South Africa.

Amphiura andreæ, Lym.

Amphipholis andreæ, Ltk., Oph. Nov. Descr., p. 106, pls. i. and ii. figs. 1*a*, 1*b*, 1*c*.

Java.

Amphiura gibbosa, Lym.

Ophiophragmus gibbosus, Ljn., Oph. Viv. Öf. Kong. Akad., p. 316, 1866.

Port Natal, South Africa.

Amphiura abdita, Vll., Amer. Journ. Sci., vol. ii., 1871, p. 132; Lym., Ill. Cat., No. viii., part 2, pl. v. fig. 82.

Noank, Connecticut.

Amphiura lobata, Ljn., Oph. Viv. Öf. Kong. Akad., p. 315, 1866.

Near Sydney, Australia.

Amphiura cuneata, Lym., Bull. Mus. Comp. Zool., vol. v., part 9, p. 225, pl. ii. figs. 34–36, 1878.

West Indies; 339 fathoms.

Amphiura tumida, Lym., Bull. Mus. Comp. Zool., vol. v., part 9, p. 225, pl. ii. figs. 28–30, 1878.

West Indies; 321 fathoms.

Amphilepis.

Amphilepis, Ljn., Oph. Viv. Öf. Kong. Akad., 1866.

Disk flat, covered with rather large naked overlapping scales and stout radial shields. Large teeth. No tooth papillæ. Mouth angle wide, of medium length, and a few (usually six) small, unequal, scale-like mouth papillæ. Second mouth tentacles enclosed between first under arm plate, outer end of side mouth shield, and outer mouth papilla. Arm flat, even and slender. Arm spines few (usually three) short and regular. Two genital openings in each interbrachial space.

The disk scales and stout radial shields are much coarser than in most Amphiuræ, as, indeed, is the general structure. Especially are the jaws and mouth frames stouter, more flaring and proportionately wider, while the nerve ring is covered by a substantial peristomial plate in a single piece of a long oval form. The genital plates have a very long head of a cylindroid form, which suddenly passes into a short flat shaft, just where a short, flat genital scale is joined, so that the two pieces give somewhat the effect of a lobster's claw. The arm bones are similar to those of the Amphiuræ, and those nearest the disk margin have a forward projection of the upper surface. (See Pl. XL. fig. 19.)

Amphilepis norvegica, Ljn. (Pl. XL. fig. 19).

Amphilepis norvegica, Ljn., Oph. Viv. Öf. Kong. Akad., p. 322, 1866; Dr. Goës, Oph. Öf. Kong. Akad., p. 632, 1871.

Amphiura norvegica, Ljn., Tillägg Skan. Oph. Öf. Kong. Akad., p. 363, pl. xv. figs. 3–3*d*, 1864.

So far as one may judge, without having a proper series, these are the adult of Ljungman's original. They have the disk as large as 9 mm. The radial shields are pretty large and separated, and there is no tentacle scale.

Station 45.—May 3, 1873; lat. 38° 34′ N., long. 72° 10′ W.; 1240 fathoms; mud.
Station 46.—May 6, 1873; lat. 40° 17′ N., long. 66° 48′ W.; 1350 fathoms; mud.

Amphilepis patens, Lym. (Pl. XIX. figs. 1–3).

Amphilepis patens, Lym., Bull. Mus. Comp. Zool., vol. vi., part 2, p. 34, pl. xii. figs. 338–340, 1879.

Disk flat, round and smooth. Mouth angle large with three wide mouth papillæ on each side. Second pair of mouth tentacles encircled by hard parts of the mouth.

Diameter of disk 11 mm. Width of arm near disk 2 mm. Mouth papillæ broad and irregular; on either side of the large prominent mouth angle, at the outer corner, are two or more or less closely joined; and, at the apex, a larger pair which, through

the gap between them, shows the small lowest tooth. Mouth shields rather small, rounded, broader than long, often with a little peak inward; length to breadth, 1 : 1·2. Side mouth shields short and wide; narrower within, where they barely meet. Under arm plates, rather small, as broad as long, shield shaped, with a gently curved outer side, lateral sides a little re-enteringly curved, and an obtuse angle within. Side arm plates wide, with a knob-like spine crest, meeting fully above and nearly or quite below. Upper arm plates transverse oval, twice as wide as long, separated by the side arm plates. Disk round and flat, but not thin; covered above and below with rounded, overlapping, flat, rather large, very thin, translucent scales, with indistinct outlines; above they are of pretty even size, except a marginal row of larger, each of which is ·7 mm. long; below they are much finer; about 3 in the length of 1 mm. Radial shields large, of a rhomboidal form, except that the outer side is rectangular, much longer than wide, strongly diverging, with the outer ends nearly touching, but separated within by a broad wedge of numerous scales; length to breadth, 3 : 1·2. Three stout, short, cylindrical, tapering, blunt arm spines; lengths to that of an under arm plate, 1·1, 1·2, 1·3 : ·8. Tentacle pores large, with one minute scale on lateral side of under arm plate. The roots of the second pair of mouth tentacles come low down, and thus seem framed by the surrounding hard parts. Colour in alcohol pale grey.

Station 299.—December 14, 1875; lat. 33° 31′ S., long. 74° 43′ W.; 2160 fathoms; grey mud.

Amphilepis papyracea, Lym.

Amphilepis papyracea, Lym., Bull. Mus. Comp. Zool., vol. vi., part 2, p. 34, figs. 429–431, 1879.

Disk thin and flat, with thin, fine scales. Three tapering, rather slender arm spines, a little longer than an arm joint. No tentacle scale. Radial shields nearly or quite separated their entire length.

(Type specimen from Station 198.) Diameter of disk 9 mm. Width of arm close to disk, without spines, 1·5 mm. Two wide, slender pointed mouth papillæ on each side, standing high up on the jaws. Four teeth, the three upper ones flat and wide, with a curved cutting edge; the lowest thicker and more conical. Mouth shields flat and small, of a wide heart shape with a rounded angle inward and outer edge rounded; length to breadth, ·7 : 1. Side mouth shields wide without, where they enclose the corner of the mouth shield, narrow and just meeting within. Under arm plates pentagonal with inner angle slightly truncated, lateral sides re-enteringly curved, and outer edge straight. Side arm plates with outer edge swollen; meeting above, and nearly so below. Upper arm plates thin and translucent, of a transverse oval shape, about twice as wide as long. Disk smooth, flat, angular and very thin, covered with small, thin, rounded, ill-defined scales. Radial shields with a vague outline, of a bent pear-seed

shape, nearly touching without, separated within by an oval of five scales; length to breadth, 2·5 : 1. Scaling on lower interbrachial space finer than that above. Three rather slender, bluntly pointed, tapering, cylindrical arm spines, a little longer than an arm joint, well up on the outer edge of side arm plates. Tentacle pores large, but without a scale. Colour in alcohol, pale grey.

Station 198.—October 20, 1874; lat. 2° 55′ N., long. 124° 53′ E.; 2150 fathoms; red clay.

Amphilepis tenuis, Lym.

Amphilepis tenuis, Lym., Bull. Mus. Comp. Zool., vol. vi., part 2, p. 35, pl. xvi. figs. 432–434, 1879.

One minute tentacle scale. One mouth papilla on each side (sometimes broken in two). Radial shields short and wide, and joined for half their length.

(Type specimen from Station 237.) Diameter of disk 4 mm. Width of arm close to disk, without spines, ·7 mm. One wide, pointed, somewhat bent mouth papilla high up on each side of the mouth angle, and a pair, short, thick, and rounded, at the apex. Mouth shields small, twice as broad as long, of a transverse diamond shape, with rounded angles. Side mouth shields three sided, short and swollen, wider without, tapering rapidly within, where they scarcely meet. Under arm plates broad pentagonal; with a short angle within, outer side nearly straight, and laterals slightly curved. The first plate is large and of a truncated wedge form. Side arm plates meeting broadly above and nearly touching below. Upper arm plates twice as broad as long, of a nearly semicircular outline, with the curve inward. Disk flat and angular, covered with very thin scales; in centre of the disk is a rosette of six large ill-defined primary plates, each nearly surrounded by minute scales. Radial shields short, wide pear-seed shaped, joined for the outer half of their length, narrowly separated within by a wedge of small scales. Scaling on interbrachial space below much finer than that above. Three short, cylindrical, bluntly-pointed arm spines. One minute, rounded tentacle scale, which easily falls off. Colour in alcohol, faint greenish-grey.

Station 237.—June 17, 1875; lat. 34° 37′ N., long. 140° 32′ E.; 1875 fathoms; mud.

Ophionema.

Ophionema, Ltk., Addit. ad Hist., part 3, 1869.

Disk, small, delicate, and a little puffed; and having long, slender, even arms. Its skin is quite naked, and its only solid parts are long, very narrow, parallel radial shields above, and genital scales below. The mouth angles are short and small, as in *Amphiura*, and bear four small papillæ, whereof two are below the teeth. Four or five small, regular arm spines. Two genital openings in each interbrachial space.

Both this genus and *Ophionephthys* are apparently naked over most of the disk. It may be, however, that a minutely squamous coat is hidden under the integument.

Species of *Ophionema* not herein described.

Ophionema intricata, Ltk., Addit. ad Hist., part 3, pp. 27, 98, 1869.
West Indies.

Ophionephthys.

Ophionephthys, Ltk., Addit. ad Hist., part 3, 1869.

Disk small, delicate, and a little puffed, and having long, slender, even arms. Its skin is apparently quite naked, except where there are rows of scales about the radia. shields, or along the margin. The mouth angles are small and short, and bear a few (four to six) small mouth papillæ. Four or five small arm spines. Two genital openings in each interbrachial space.

Species of *Ophionephthys* not herein described.

Ophionephthys limicola, Ltk., Addit. ad Hist., part 3, pp. 25, 98, 1869.
West Indies.

Ophionephthys phalerata, Lym., Bull. Mus. Comp. Zool., vol. iii., part 10, p. 229, pl. vi. figs. 7–9, 1874.
Philippines.

Ophiocnida.

Ophiocnida, Lym., Ill. Cat. Mus. Comp. Zool., No. i., 1865.

Disk small and delicate, furnished with uncovered radial shields, its coat of naked, overlapping scales is beset with small thorns or grains. Teeth. No tooth papillæ. Mouth angles short and small, bearing a few (four to six) little mouth papillæ. Arms long, slender, even, more or less flattened. Arm spines short and regular. Two genital openings in each interbrachial space.

Ophiocnida is *Amphiura* beset with small spines or grains, just as *Ophiactis* is *Amphiura* of a very robust structure with short wide arms. The three genera differ within themselves very much, and shade into each other on their borders; and they are almost as closely allied with *Ophiopholis*, *Ophionema*, *Ophionephthys*, *Amphilepis*, &c., as with each other. But, while as genera they are difficult to define, the species within the genera are curiously constant, well marked, and unvarying. In this they contrast with such a genus as *Ophiothrix*, well and clearly set off from its neighbour *Ophiocnemis*, but having species which are almost impossible of distinction.

TABLE OF SPECIES OF *Ophiocnida*.

Short spines on disk.	9–10 arm spines.	One spiniform mouth papilla on each side, and a bead-like pair at apex of mouth angle. Disk puffed,	*Ophiocnida putnami.*
		Four to five mouth papillæ on each side. Two spiniform tentacle scales. Disk puffed,	*Ophiocnida olivacea.*
	7–8 arm spines.	Arm spines flat; one of them often with a terminal cross-piece. Arms very long,	*Ophiocnida brachiata.*
		Arm spines rough. Four sharp mouth papillæ on each side. Two spiniform tentacle scales,	*Ophiocnida caribea.*
	5–6 arm spines.	Lowest arm spine thick and rough. Two small mouth papillæ on each side, and a bead-like pair at apex of mouth angle. Disk puffed,	*Ophiocnida scabra.*
		Lowest arm spine longest. One spiniform mouth papilla on each side, and a bead-like pair at apex of mouth angle,	*Ophiocnida pilosa.*
	3 arm spines.	Three blunt, nearly equal mouth papillæ on each side. Disk scales thick,	*Ophiocnida scabriuscula.*
		Similar to preceding, but disk spines longer,	*Ophiocnida hispida.*
		Radial shields very narrow,	*Ophiocnida echinata.*
		One very wide mouth papilla on each side, and a clump of four minute at apex of mouth angle,	*Ophiocnida abnormis.*
Granules on disk.		Two unequal mouth papillæ on each side, and a pair at apex of mouth angle, which are pointed and larger,	*Ophiocnida filogranea.*
		Three nearly equal, bead-like mouth papillæ on each side,	*Ophiocnida loveni.*

Ophiocnida pilosa, Lym. (Pl. XIX. figs. 7–9).

Ophiocnida pilosa, Lym., Bull. Mus. Comp. Zool., vol. vi., part 2, p. 32, pl. xii. figs. 341–343, 1879.

Disk scaling hidden. Disk set with stout simple spines. Five tapering arm spines, the lowest one longest. A slender mouth papilla on each side, and a pair of thick ones at apex of mouth angle.

(Type specimen from Station 162.) Diameter of disk 5·2 mm. Arm broken, but apparently eight or ten times the diameter of disk. Width of arm near disk 1·2 mm. The short narrow mouth angle has at its base on either side a spiniform papilla, and at its apex a pair, stouter and more angular. Mouth shields longer than broad, nearly oval. Side mouth shields triangular, somewhat curved round the mouth shield, not meeting within. Under arm plates narrow, longer than broad, with eight sides, but having the angles rounded and nearly obliterated; lateral sides re-enteringly curved.

Side arm plates feeble, nearly or quite meeting above, but not below. Upper arm plates nearly twice as wide as long, of a transverse oval shape, with inner curve deeper than outer. Disk delicate but rather thick, sparsely set above and below with small spines; in the centre may be seen some round, very thin, primary plates; the rest seems naked, but on drying a very fine, delicate scaling appears. Radial shields much longer than broad, slightly curved, meeting without, widely separated within; length to breadth, 1 : ·5. Five cylindrical, tapering, blunt arm spines, the lowest somewhat the longest; lengths to that of an under arm plate, ·5, ·5, ·5, ·5, ·7 : ·5. No tentacle scales. Colour in alcohol, pale grey.

Station 162.—April 2, 1874; off East Moncœur Island, Bass Strait; 38 fathoms; sand. Station 212.—January 30, 1875; lat. 6° 55′ N., long. 122° 15′ E.; 10 to 20 fathoms; sand.

Ophiocnida scabra, Lym. (Pl. XIX. figs. 4–6).

Ophiocnida scabra, Lym., Bull. Mus. Comp. Zool., vol. vi., part 2, p. 33, pl. xii. figs. 344–346, 1879.

Disk much puffed. Radial shields long and narrow. Five or six short, stout arm spines, the second longest. Two minute mouth papillæ on either side, and a pair of larger ones at apex of mouth angle.

(Type specimen from Station 128.) Diameter of disk 6 mm. Length of arm about 40 mm. Width of arm near disk 1·3 mm. Two minute, bead-like papillæ on each side of base of small mouth angle, and a pair, much larger, at its apex. Mouth shields small, rounded, about as broad as long. Side mouth shields small, bent, wider without than within, where they do not meet. Under arm plates as broad as long, bounded by a curve without, and within by three sides of an octahedron. Side arm plates narrow, widely separated above and below, and having a feeble spine ridge. Upper arm plates two and a half times as broad as long, of a clean transverse oval shape. Disk extremely puffed in the interbrachial spaces by the swollen ovaries. This swollen portion, both above and below, is naked, and sparsely set with minute, peg-like spines; but above the surface is finely and pretty uniformly scaled, with about six scales in the length of 1 mm. Radial shields long and very narrow, slightly bent towards each other, nearly or quite separated their whole length by a narrow strip of two scales; length to breadth, 1·5 : ·3 Six short, thick, microscopically thorny arm spines, whereof the two uppermost are longest, somewhat flattened, pointed, and have a minute beak; those below diminish constantly in length, and are almost club-shaped; lengths to that of a lower arm plate, ·5, ·7, ·4, ·3, ·3, ·2 : ·3. One round tentacle scale. Tentacles papillose, as in *Ophiothrix*. Colour in alcohol, pale yellowish-brown, mottled and speckled with darker.

Station 128.—September 14, 1873; off Bahia, Brazil; lat. 13° 6′ S., long. 38° 7′ W.; 1275 fathoms; mud.

This eccentric species might almost as well go with *Ophiactis*.

Species of *Ophiocnida* not herein described.

Ophiocnida brachiata, Lym., Ill. Cat. Mus. Comp. Zool., No. i. p. 12, 1865; Ljn. Oph. Viv., Öf. Kong. Akad., p. 317, 1866; Ludwig, Echin. des Mittelmeeres, p. 550.

Asterias brachiata, Montagu, Trans. Linn. Soc., vol. vii. p. 84, 1804.
Ophiocoma brachiata, Fbs., Brit. Starfishes, p. 45, 1841.
Amphiura Neapolitana, Sars, Mid. Lit. Fauna, p. 94, 1857.
Ophiocnida Neapolitana, Lym., Ill. Cat. Mus. Comp. Zool., No. i. p. 12.

North European Seas and Mediterranean; 20 fathoms.

Ophiocnida abnormis, Lym., Bull. Mus. Comp. Zool., vol. v., part 9, p. 227, pl. ii. figs. 37–39, 1878.

West Indies; 101 fathoms.

Ophiocnida scabriuscula, Lym., Ill. Cat. Mus. Comp. Zool., No. i. p. 135, 1865.

Amphiura scabriuscula, Ltk., Addit. ad Hist., part 2, p. 118, 1859.
Ophiocnidella scabriuscula, Ljn., Dr. Goës, Oph. p. 649.

West Indies.

Ophiocnida hispida, Lym., Ill. Cat. Mus. Comp. Zool., No. i. p. 133, 1865.

Ophiolepis hispida, Le Conte, Proc. Phil. Acad., vol. v. p. 318, 1851.
Amphiura (*Ophiolepis*) *hispida*, Ltk. Addit. ad Hist., part 2, pp. 114, 119.

West Coast of Central America.

Ophiocnida filogranea, Lym., Ill. Cat. Mus. Comp. Zool., No. viii., part 2, p. 20, 1875, Outline figs. 88, 89.

Cedar Keys, Florida.

Ophiocnida loveni, Lym.

Ophiophragmus loveni, Ljn., Om några nya arter, Öf. Kong. Akad., p. 165, 1866; Oph. Viv. Of. Kong. Akad., p. 316, 1866.

Rio de Janeiro; 3 to 4 fathoms.

Ophiocnida echinata, Lym., Bull. Mus. Comp. Zool., vol. iii., part 10, p. 230, pl. iv. figs. 22, 23, 1874.

Ophiophragmus echinatus, Ljn., Oph. Viv. Öf. Kong. Akad., p. 316, 1866.

Between Batavia and Singapore.

Ophiocnida caribea (?), Ljn., Dr. Goës, Oph. Öf. Kong. Akad., p. 636, 1871.

Anguila, West Indies; 300 to 400 fathoms.

Ophiocnida olivacea, Lym., Bull. Mus. Comp. Zool., vol. i., part 10, p. 340, 1869; Ill. Cat. Mus. Comp. Zool., No. vi., pl. i. figs. 7, 8; Bull. Mus. Comp. Zool., vol. v., part 9, p. 227.

West Indies; 40 to 120 fathoms; off Newport, Rhode Island; 86 to 126 fathoms.

Ophiocnida putnami, Lym., Ill. Cat. Mus. Comp. Zool., No. vi. p. 11, pl. i. fig. 9, 1871.

Hong Kong.

Ophiopus.

Ophiopus., Ljn., Viv. Öf. Kong. Akad., 1866.

Disk smooth and without spines, and covered by rather fine scales which separate the rounded primary plates. Radial shields very small and somewhat widely separated. Arms short and stout, with projecting side arm plates, which bear a few (three to four) stout, regular spines. Mouth angles small and short bearing two flat papillæ on either side and a single one at the apex. Above the lateral papillæ are one or two others. Two genital openings in each interbrachial space.

I am at a loss to separate this genus from some species of *Ophiactis* that have no disk spines (*e.g.*, *Ophiactis canotia*). The only character seems to be the presence of one or two additional mouth papillæ above the lateral ones, but these are perhaps only the scales of the first pair of mouth tentacles. My friend Dr. Ljungman considers this genus between *Ophioglypha* and *Amphiura*, but it would be hard to say what were its affinities with the former.

He informs me, in a recent letter, that *Ophiaregma*, G. O. Sars, is a synonym of this genus, which leads to the inference that it has no genital openings.

The presence or absence of genital openings among Ophiurans has not yet been fully worked out. An observer is apt to take the crease in the disk, close to the arm, for a true opening, while there may be none at all.

In *Ophiocymbium* and in *Ophiothamnus* I have not been able to detect any opening, although the skin of that region was extremely thin and might readily be ruptured. The situation is more puzzling in species covered by massive, strongly soldered plates, such as *Ophiomusium pulchellum*, where I could detect no distinct opening; and *Ophiomusium flabellum*, whose side arm plates cover the whole interbrachial space and seem to preclude the idea of genital openings.

Species of *Ophiopus* not herein described.

Ophiopus arcticus, Ljn., Oph. Viv. Öf. Kong. Akad., p. 309, 1866.

Ophiaregma abyssorum, G. O. Sars, Nye Echin, Vid. Selsk. Forh., p. 42, 1872.

Spitzbergen, Norway; 400 fathoms.

Hemipholis.

Hemipholis, Agas., MS.; Lym., Ill. Cat. Mus. Comp. Zool., No. i., 1865.

Disk, above, covered with rounded, rather thick scales, and with large united radial shields; below, naked. Disk slightly indented, at the base of each arm. Teeth. No tooth papillæ. Mouth angle extremely narrow, with a tooth at the apex, and a small papilla at the outer corner. Side mouth shields touching each other, so as to form a continuous ring round the mouth. Three short, tapering arm spines. Two genital openings, beginning outside the mouth shields.

This genus, scarcely to be separated by external characters from some species of *Amphiura* that are naked below, presents considerable differences in the skeleton. In the first place, there is no genital scale, but only a genital plate, with a clubbed outer end and a strongly curved slender shaft. The mouth frames are much larger than in *Amphiura* with prolonged wings, and a small but well-marked single peristomial plate.

The arm bones are wider, with thicker wings and a less marked forward projection of the upper surface. Their lower surface presents an immense canal (Pl. XL. fig. 9, *t*), which rises in the substance of the bone like a high, wide arch, and changes the usual position of the articulating peg (6). (See Plate XL. figs. 8–12.)

Hemipholis cordifera, known long ago by the description of Bosc, is plentiful in the harbour of Charleston, S.C., where it was collected by Professor Agassiz in 1852, and was carefully examined in the living state by the late Professor H. J. Clark. Besides the peculiarities already noted in the skeleton, the tentacles are papillose (Pl. XLIV. figs. 13, *r*, 14, 15). The papillæ, as well as the tip of the tentacle itself, are imperforate, as appears in the section (fig. 14). The centre, however, is hollow, and contains a long spiral, like a half partition, which is apparently muscular and doubtless aids in retraction. Fig. 13 gives an excellent picture of a part of the under side of the living animal. Between the points of the teeth, in three of the interbrachial spaces, may be seen a white line, which is the edge of the mouth sphincter. The females were then (January) full of eggs, one of which (fig. 16) is shown considerably magnified.

The species is, I suspect, viviparous, as I found minute young, clinging to the arms and disk of the adult. One of these, having a disk but half a millimetre in diameter (Pl. XL. fig. 12) displayed only the six primary back plates (*g*, *g'*), and the beginning of one interbrachial. There were as yet no radial shields, although the arms had already ten joints. It was not until the disk was 1 mm. across that the beginnings of radial shields were visible (fig. 11, *l*). Besides these there were not only the primary plates (*g*, *g'*) but one brachial and three interbrachial. It thus appears that radial shields, so nearly universal among Ophiurans, are not special plates, but entirely homologous with other disk scales, and by no means the first to appear.

Species of *Hemipholis* not herein described.

Hemipholis cordifera, Lym. (Pl. XL. figs. 8–12; Pl. XLIV. figs. 13–16).

Hemipholis cordifera, Lym., Ill. Cat. Mus. Comp. Zool., No. i. p. 137, pl. i. figs. 1–3, 1865.
Asterias cordifera, Bosc, Hist. Nat. Vers., vol. ii. p. 138, pl. ii. fig. 3, 1830.
Ophiura elongata, Say, Journ. Phil. Acad., vol. v. p. 146, 1825.
Ophiolepis elongata, Müll. & Tr., Syst. Ast., p. 95, 1842; Stimp., Proc. Bost. Soc. Nat. Hist., vol. iv. p. 225, 1852.
Ophiolepis uncinata, Ayres, Proc. Bost. Soc. Nat. Hist., vol. iv. p. 250, 1852.
Hemipholis elongata, Agas., MS.
Amphiura elongata, Ltk., Addit. ad Hist., part 2, p. 115, 1859.
Amphiura cordifera (Bosc), Ltk., Addit. ad Hist., part 2, p. 120, pl. iii. fig. 2, 1859.

West Indies.

Hemipholis gracilis, Vll., Trans. Conn. Acad., vol. i., part 2, p. 262, 1867.
Hemipholis affinis, Ljn., Oph. Viv. Öf. Kong. Akad., 1866.

Guayaquil.

Hemipholis microdiscus, Duncan, Journ. Linn. Soc., vol. xiv. p. 467, pl. x. figs. 20–22, 1879.

Korean Strait; 51 fathoms.

Hemipholis wallichii, Duncan, Journ. Linn. Soc., vol. xv. p. 138, pl. vi., is a very young animal, with a disk not more than .5 mm. in diameter. It is not possible to distinguish either the genus or the species.

Ophiophragmus.

Ophiophragmus, Lym., Ill. Cat. Mus. Comp. Zool., vol. i., 1865.

Disk small and delicate, furnished with naked radial shields, and fine overlapping scales; the scales along the edge of the disk are turned up, so as to make a little fence. Teeth. No tooth-papillæ. Mouth angles short and small, bearing six close-set little papillæ. Arms slender, even and more or less flattened. Arm-spines short and regular. Two genital openings in each interbrachial space.

It is in the structure of the mouth frames that this genus, as illustrated in *Ophiophragmus wurdemani* is peculiar. The upper brachial rims of the contiguous halves form an elevated crescent embracing the outer end of the mouth slit; while the interbrachial rims or wings (Pl. XL. fig. 4, *f*) rise as steep crests whose free side (fig. 7) has deep radiating grooves for the attachment of the external mouth frame muscle. Similar, but not at all so large, grooves are found in *Ophiocoma*, but there is nothing in the character of either genus that seems to call for such a strong attachment. In general build the skeleton is more powerful than that of *Amphiura*. The radial shields are wide and thick; the genital plates stout and club-headed, while the arm bones are stouter and

thicker than in *Amphiura*, and have no upper outward projection. Their under surface has a very large canal (fig. 5, *t*), but not so high nor so wide as in *Hemipholis*.

See Plate XL. figs. 4–7.

Species of *Ophiophragmus* not herein described.

Ophiophragmus wurdemani, Lym. (Pl. XL. figs. 4–7).

Ophiophragmus Wurdemani, Lym, Ill. Cat. Mus. Comp., Zool., No. i. p. 132, 1865.
Amphiura Wurdemani, Lym., Proc. Bost. Soc. Nat. Hist., vol. vii. p. 169, 1860.

West Coast of Florida.

Ophiophragmus marginatus, Lym., Ill. Cat. Mus. Comp. Zool., No. i. p. 131, 1865.

Amphiura marginata, Örst. & Ltk., Vid. Meddel., March 1856, p. 26; Addit. ad Hist., part 2, p. 119, pl. iii. fig. 3, 1859.

West Coast of Central America.

Ophiophragmus septus, Lym., Ill. Cat. Mus. Comp. Zool., No. i. p. 12, 1865.

Amphiura septa Ltk., Addit. ad Hist., part 2, p. 120, 1859.

West Indies; 47 fathoms.

Ophiopsila.

Ophiopsila, Fbs., Trans. Linn. Soc., vol. xix., 1842.

Disk covered with very minute, overlapping, smooth scales, which nearly or quite cover the narrow radial shields. Teeth. Tooth papillæ sometimes present and sometimes wanting. A few (six to eight) side mouth papillæ. Arm spines short, flattened, numerous (six to twelve). Lowest tentacle scale very long, like a spatula, or a dagger. Lower arm plates faintly indicated and sunken, making a groove in which lie the long tentacle scales. Two genital openings in each interbrachial space, beginning outside the mouth shields.

The disk is enclosed by extremely fine and even imbricated scales, which more or less spread over the upper surface of the stout narrow, curved and bar-like radial shields, to which are jointed the cylindroid heads of the genital plates. These become flat, at about one-third of their length, and have there attached a flat genital scale, which is prolonged quite to the radial shields by a slender additional piece. The arm bones, not unlike those of *Amphiura* in outline, differ from allied genera by the massive shoulder in the outer surface (Pl. XL. fig. 2), which forms the hollow to receive the umbo of the preceding bone. The mouth frames are small, simple and without deep grooves, and have a small linear peristomial plate, in one or two pieces. Instead of a jaw plate soldered with the jaws, as in most *Amphiuræ*, there is here a distinct plate, thick and very wide, which bears large oblong teeth.

See Plate XL. figs. 1–3.

Species of *Ophiopsila* not herein described.

Ophiopsila aranea, Fbs., Trans. Linn. Soc., vol. xix. p. 149, 1842; Ludwig, Echin. des Mittelmeeres, p. 550.

Ophianoplus marmoreus (?), Sars, Mid. Lit. Fauna, p. 23, 1859.
Ophiopsila marmorea, Ltk., Addit. ad Hist., part 2, p. 136, 1859.

Mediterranean; 15 to 40 fathoms.

Ophiopsila annulosa, Ltk., Addit. ad Hist., part 2, p. 136, 1859; Ludwig, Echin. des Mittelmeeres, p. 551.

Ophianoplus annulosus, Sars, Mid. Lit. Fauna, p. 83, pl. i. figs. 2–7, 1857.

Mediterranean.

Ophiopsila riisei, Ltk. (Pl. XL. figs. 1–3).

Ophiopsila Riisei, Ltk., Addit. ad Hist., part 2, p. 136, 1859, pl. v. fig. 2.; Lym., Ill. Cat. Mus. Comp. Zool., No. i. p. 150, figs. 16, 17; Bull. Mus. Comp. Zool., vol. v., part 9, p. 228.

West Indies; littoral to 37 fathoms.

Ophiopsila fulva, Lym., Bull. Mus. Comp. Zool., vol. v., part 9, p. 227, pl. ii. figs. 25–27, 1878.

West Indies; 13 to 175 fathoms.

Ophionereis.

Ophionereis, Ltk., Addit. ad Hist., part 2, 1859.

Disk covered with fine overlapping scales, usually uniform, except those along margin, which are somewhat larger. Radial shields nearly hidden by the scale coat. Large oblong teeth. Mouth angle small and short, and bearing nine or ten close-set little papillæ. A few (three to five) short, smooth arm spines. One large tentacle scale. Each upper arm plate has a supplementary piece on either side. Two genital openings beginning outside the mouth shields in each interbrachial space.

Seen from their under side, the radial shields are found to be long and narrow with an enlarged outer end (*Ophionereis reticulata*), or wide and rudely three-sided (*Ophionereis annulata*), but in either case they are widely separated. The genital plates are long, club-headed and moderately stout, and have attached, just at the inner part of the head, a thin genital scale, which extends quite to the mouth shield. The mouth frames are rather simple and not large, about as large as in *Amphiura*, and they support very small jaws bearing a distinct jaw plate. There is nothing but an irregular lime crust to represent the peristomial plate. The disk arm bones, beyond the first two, have on their upper surface a long projection forward fitting into a slot in the next

bone, in a way that brings to mind *Ophiothrix*. *Ophionereis* is found in shallow tropical waters all over the world, and yet is remarkable for its few species and their close resemblance.

See Plate XL. figs. 13–15.

TABLE OF SPECIES OF *Ophionereis*.

Always three arm spines.	Disk scales very fine and thin, 13–15 to a millimetre in centre of upper disk, and in interbrachial spaces below, ...	*Ophionereis dubia.*
	Extremely like *Ophionereis dubia* save in colour (a purple patch outside mouth shields, and in general light yellowish). In young perhaps disk scales are coarser, ...	*Ophionereis reticulata.*
	Very like *Ophionereis reticulata*, except middle arm spine usually longer; disk scales of young coarser. Colour olive, with purple arm bands, .	*Ophionereis annulata.*
	Scaling coarsest of all, with numerous larger scales. At centre of disk about 9 in the length of a millimetre. Young with scales decidedly thickened,	*Ophionereis porrecta.*
4 arm spines.	Scaling about the same as in *Ophionereis dubia*, ...	*Ophionereis schayeri.*
	Scaling coarser than in the preceding species, with more large scales, .	*Ophionereis albomaculata.*

Ophionereis dubia, Lym., Ill. Cat. Mus. Comp. Zool., No. i. p. 149, 1865; V. Martens, Wieg. Archiv, vol. xxxvi. p. 246.

Ophiure, Savigny, Descr. de l'Egypte Echin., pl. i. figs. 3^1–3^{10}, 1809–25.
Ophiolepis dubia, Müll. & Tr., Syst. Ast., p. 94.
Ophionereis crassispina, Ljn., Oph. Viv. Öf. Kong. Akad., p. 311, 1866.

Professor P. M. Duncan[1] writes this species *Ophionereis dubia*, Audouin. Here is one more example of the troubles that come from placing authorities according to honour or credit, instead of using them as parts of an exact and convenient system of registration. Anybody who is acquainted with the tradition of the Jardin des Plantes knows that Audouin is not entitled to the "credit of discovery and exact representation." Savigny discovered the species and had it drawn. When, after long delay in the publication, Savigny broke down, Audouin was appointed to edit this part of the work. His editing was such as only Carlyle could properly describe!

It is hardly needful to add that a student, seeing the name *Ophionereis dubia*, Audouin, might well hunt for a week, only to find at last that Audouin never called it by either of those names, did not describe it, and, in fact, knew nothing about it.

Fiji Islands, same species? Gomera, Canary Islands, same species? Amboyna; 100 fathoms.

[1] Linn. Soc. Jour. Zool., vol. xiv. p. 464.

Ophionereis reticulata, Ltk. (Pl. XL. figs. 13–15).

Ophionereis reticulata, Ltk., Addit. ad Hist., part 2, p. 110, 1859, pl. iii. figs. 6*a*, 6*b*; Lym., Ill. Cat. Mus. Comp. Zool., No. i. p. 141; Bull. Mus. Comp. Zool., vol. v., part 9, p. 224.
Ophiura reticulata, Say, Journ. Phil. Acad., vol. v. p. 148, 1825.
Ophiolepis nereis, Ltk., Vid. Meddel., March, 1856, p. 11.

Bahia; 7 to 20 fathoms. Bermudas.

Ophionereis schayeri, Ltk., Addit. ad Hist., part 2, p. 110, 1859.

Ophiolepis Schayeri, Müll. & Tr., Wieg. Archiv, vol. x. p. 182, 1844.
Ophionereis fasciata (?), Hutt., Echin. New Zealand, p. 2, 1872.

Station 162.—April 2, 1874; off East Moncœur Island, Bass Strait; 38 to 40 fathoms; sand.

Ophionereis porrecta, Lym., Proc. Bost. Soc. Nat. Hist., vol. vii. p. 260, 1860; Ill. Cat. Mus. Comp. Zool., No. i. p. 147, figs. 14, 15; VII., Proc. Bost. Soc. Nat. Hist., vol. xii. p. 390.

Ophionereis squamata, Ljn., Oph. Viv. Öf. Kong. Akad., p. 310, 1866.
Ophionereis variegata (?), Duncan, Journ. Linn. Soc., vol. xv. p. 462, pl. x. figs. 15, 16, 1879.

Honolulu Reefs; Honolulu.

Species of *Ophionereis* not herein described.

Ophionereis annulata, Lym., Proc. Bost. Soc. Nat. Hist., vol. vii. p. 203, 1860; Ill. Cat. Mus. Comp. Zool., No. i. p. 143; VII., Trans. Conn. Acad., vol. i., part 2, p. 259.

Ophiolepis annulata, Le Conte, Proc. Phil. Acad., vol. v. p. 317, 1851.
Ophiolepis triloba, Ltk., Vid. Meddel., March 1856, p. 23; Addit. ad Hist., part 2, p. 112, 1859.
Ophionereis Xantusii, Lym., Proc. Bost. Soc. Nat. Hist., vol. vii. p. 258, 1860; Ill. Cat. Mus. Comp. Zool., No. i. p. 145.

West Coast of Central America; littoral to 35 fathoms.

Ophionereis albomaculata, E. A. Smith, Proc. Zool. Soc. Lond., p. 92, 1877.
Galapagos.

Ophiocymbium.

Ophiocymbium, Lym., Anniv. Mem. Bost. Soc. Nat. Hist., 1880.

Disk flat and covered with delicate overlapping scales, without radial shields externally visible. It overlies, and is scarcely attached to the arms, like the borders of a Basque cap, and there seem to be no genital openings. Arm spines along outer edge of side arm plates, but at an angle. On jaw plate, a tuft of small spines which correspond to teeth and tooth papillæ. Mouth papillæ squarish and arranged in a close line.

Tentacle pores very large; those of the second mouth tentacles set in a socket, much like the rest.

This genus is of rather doubtful position. While its general structure seems to place it here, the situation of the arm spines would almost bring it in the first great group.

Ophiocymbium cavernosum, Lym. (Pl. XXVII. figs. 1–3).

Ophiocymbium cavernosum, Lym., Anniv. Mem. Bost. Soc. Nat. Hist., p. 7, 1880.

Four arm spines. Two or three disk scales in the length of 1 mm. Side mouth shields small and not meeting within.

(Type specimen from Station 157.) Diameter of disk 7·5 mm. Arms broken, but apparently about three times the diameter of the disk. Width of arm, without spines, 1·2 mm. At apex of mouth angle is a boss-like jaw plate bearing a cluster of four or five short, blunt, irregularly placed spines, which correspond to teeth and tooth papillæ; inside these, and along the margin of the wide jaws, on either side, is a close line of three or four flat, squarish mouth papillæ, whereof the outermost stands on the margin of the socket of the second mouth tentacle, while the opposite margin, formed by a portion of the side mouth shield, bears two flattened, spine-like tentacle scales. Mouth shields small and of a rounded heart shape; length to breadth, 1 : 1. Side mouth shields small, wide without, but narrow and not meeting within. First under arm plate pretty large and wide, three sided, with an angle inward. Those beyond are shaped like an axe, with a wide, curved cutting edge, and a narrow body pointing inward. The narrowness of the inner portion comes from the encroachment of the large tentacle pores. Side arm plates long but not prominent; meeting above and below. Upper arm plates small and triangular, with an angle inward. Disk thin and flattened, with a tender skin covered by very thin, delicate, overlapping scales; two or three in the length of 1 mm. No radial shields can be seen from the outside. There are apparently large genital openings, but these are merely the creases on either side of the arm; for, in reality, the under disk surface, with a very delicate scaling, is continuous over the arm, and there are no genital openings in their usual position. Four delicate, sharp, somewhat flattened, arm spines which, though placed on the outer edge of side arm-plates, have a considerable lateral motion. No tentacle scales except to the mouth tentacles.

Colour in alcohol: disk, pale greenish-grey; arms, straw.

Station 157.—March 3, 1874; east of Kerguelen Islands; lat. 53° 55′ S., long. 108° 35′ E.; 1950 fathoms; diatom ooze.

Ophioplax.

Ophioplax, Lym., Ill. Cat. Mus. Comp. Zool., No. viii. part 2, 1875.

Teeth; no tooth papillæ. Mouth angle small and short, bearing numerous (eleven)

sharp, close-set papillæ. Scaling of disk beset with granulation. Arms long and rather stiff, arm spines few (three) and smooth, arranged on the ridges of the side arm plates. One very large tentacle scale on the side arm plate, and others, minute, on the under arm plate. Two long genital openings in each interbrachial space.

The genus stands near *Ophiocnida*, but is distinguished by the numerous mouth papillæ arranged as in *Ophiura*, and by the singular tentacle scales.

By its internal, even more than by its external structure, *Ophioplax* is separated from such genera as *Ophiocnida*. While the slender genital plates, thin genital scales, and arm bones with a forward projection remind us of the Amphiuræ; the radial shields, continued inward by a line of large overlapping scales, suggest *Ophiocoma*; and the wide spreading, solid mouth angles, with large tentacle sockets, and the thick peristomial plate, in two pieces, are even larger than in *Amphilepis*.

See Plate XLI. fig. 7.

Species of *Ophioplax* not herein described.

Ophioplax ljungmani, Lym. (Pl. XLI. fig. 7).

Ophioplax ljungmani, Lym., Ill. Cat. Mus. Comp. Zool., No. viii., part 2, p. 22, 1875, pl. ii. figs. 24, 25; Bull. Mus. Comp. Zool., vol. v., part 9, p. 228.

West Indies; 80 to 127 fathoms.

Ophiostigma.

Ophiostigma, Ltk., Vid. Meddel., Jan. 1856.

Disk granulated. Teeth. No tooth papillæ. Basal mouth papillæ very long, stout, and broad; the others small and few, arranged so as to cover the end as well as the sides of the angle of the mouth. Arm spines three, short, smooth, arranged along the sides of the side arm plates. Side mouth shields large; nearly, or quite, touching, so as to form a ring round the mouth. Mouth apparatus, as a whole, forming a distinct, raised pentagon. Two genital openings, beginning outside the mouth shields.

This shares with *Ophiothamnus* a curious skeleton modification. It is, that the genital plates instead of occupying their normal position at the sides of the arm, lie above it and hide it (Pl. XLII. fig. 16, *o*). So that the thin warped genital scales (*n*) are below, and their plane is at right angles with that of the plates. The disk scaling is very coarse, thick and irregular, with large three-sided radial shields having prolonged angles. The mouth frames are compact and plain, without deep grooves. They have a rather small, rounded peristomial plate of a crusty consistency. The jaw is small and soldered with the jaw plate, as in *Amphiura*.

See Plate XLII. fig. 16.

Ophiostigma africanum, Lym. (Pl. XVIII. figs. 17–19).

Ophiostigma africanum, Lym., Bull. Mus. Comp. Zool., vol. vi., part 2, p. 41, pl. xiii. figs. 368–370, 1879.

Arms more than eight times the diameter of disk. Outer mouth papillæ very wide. Radial shields long, narrow, and joined.

(Type specimen from Cape de Verde Island.) Diameter of disk 2·2 mm. Length of arm 18 mm. Width of arm near disk ·6 mm. Three mouth papillæ on each side of a mouth angle, whereof the two inner ones are small, short, and almost conical, while the outer is straight and very wide, extending from the first under arm plate about two-thirds the length of an angle. Mouth shields three-sided, with rounded angles, bounded without by a curve, and within by a rounded angle; length to breadth, ·2 : ·3. Side mouth shields wide, a little broader without than within, where they fully meet. Under arm plates small, pentagonal, with outer side nearly straight, lateral sides a little re-enteringly curved, and an angle within. Side arm plates nearly meeting above and below, and having a thick, low, spine crest. Upper arm plates small, irregular transverse oval, with the inner curve deeper than the outer. Disk rather thick, standing nearly clear of the arms, as is usual in the genus: covered with fine, thin, nearly equal, indistinct scales, whereof most are rounded, but some, near the centre, are angular: there are about twelve in the length of 1 mm. where they are finest. Along margin of disk are minute, peg-like, scattered spines, which are not jointed at the base. Radial shields long, narrow, and closely joined; length to breadth, ·6 : ·2. At their outer ends are visible the points of the genital plates, in two little lobes. Three stout, equal, peg-like, very short arm spines, standing nearly at right angles with the arm. Two minute, longer than broad tentacle scales standing diagonally with the arm plate. Colour in alcohol, nearly white.

St. Vincent, Cape de Verde Islands.

Ophiostigma africanum differs from *Ophiostigma isacanthum* in having longer arms, and longer, narrower radial shields; and from *Ophiostigma formosa* by its wide outer mouth papilla and longer arms.

Species of *Ophiostigma* not herein described.

Ophiostigma isacanthum, Lym. (Pl. XLII. fig. 16).

Ophiostigma isacanthum, Lym., Ill. Cat. Mus. Comp. Zool., No. i. p. 103, figs. 8, 9, 1865; Bull. Mus. Comp. Zool., vol. v., part 9, p. 224.

Ophiura isacantha, Say, Journ. Phil. Acad., vol. v., p. 150, 1825.

Ophiostigma moniliforme, Ltk., Addit. ad Hist., part 2, p. 132, 1859.

West Indies; littoral to 63 fathoms.

Ophiostigma tenue, Ltk., Vid. Meddel., Jan. 1856, p. 13; Addit. ad Hist., part 2, p. 131, pl. iii. fig. 9.

West Coast of Central America.

Ophiostigma formosa, Ltk., Oph. Nov. Descr., p. 3., pls. i. and ii. figs. 5*a*, 5*b*, 1872.

Formosa.

Ophiochytra.

Ophiochytra, Lym., Anniv. Mem. Bost. Soc. Nat. Hist., 1880.

Disk covered with little, overlapping scales, and small radial shields. Teeth; no tooth papillæ. The small short mouth angles support a line of squarish, close-set mouth papillæ on each side. Large side arm plates, which meet above and below, and bear on their outer edge small spines, which, however, stand at nearly a right angle to the arm. Two genital openings in each interbrachial space.

Ophiochytra epigrus, Lym. (Pl. XXVIII. figs. 12–14).

Ophiochytra epigrus, Lym., Anniv. Mem. Bost. Soc. Nat. Hist., pl. ii. figs. 17–19, 1880.

Two small peg-like arm spines. One tentacle scale. Very small radial shields, wider than long.

(Type specimen from Station 276.) Diameter of disk 5·5 mm. Length of arm about 13 mm. Width of arm without spines 1·2 mm. Teeth small, wide and short, closely soldered to a small and very thin jaw plate. On either side of mouth angle, a close row of three or four flattened, squarish mouth papillæ, whereof the outermost is largest and acts as tentacle scale to the second mouth tentacle. Mouth shields small, of a pointed heart-shape, with the angle inward; length to breadth, 0·8 : 0·6. Side mouth shields long, and extending far beyond the mouth shields, tapering inward where they nearly or quite meet. First under arm plate about as broad as long, with a curved, or slightly angular outer side, and a tapering angle inward; the plates beyond are axe-shaped, much wider without than within, bounded without by a curve, on the lateral sides by re-entering curves, and within by an obtuse angle. Side arm plates long and meeting broadly above and below, thickened on their outer edge, but not flaring. Upper arm plates small, with three nearly equal sides, and an angle inward. Disk round, slightly arched, covered above with pretty regular, rounded overlapping scales, two or three in the length of 1 mm.; and below by larger and more angular scales. Radial shields very small, wider than long, and touching. Genital openings large, extending from mouth shield to margin of disk. Two very short, peg-like arm spines standing on outer edge of sides arm plates, but at nearly a right angle to arm. One oval tentacle scale.

Colour in alcohol, pale greenish-grey; arms lighter.

Station 276.—September 16, 1875; near Low Archipelago; lat. 13° 28 S., long. 149° 30′ W.; 2350 fathoms; red clay.

This solitary representative is highly interesting as almost the only deep-sea Ophiuran found by the "Challenger" in the immense distance between the Sandwich Islands and the south-west coast of South America.

Ophiocentrus.

Ophiocentrus, Ljn., Oph. Viv. Öf. Kong. Akad., 1866.

Disk covered by a soft skin, except a portion of radial shields, and set with short spines. Four mouth papillæ to each angle, whereof two are very thick and standing under the teeth; and two minute ones, standing at the outer corners. Arms long (ten times diameter of disk), with very narrow upper arm plates, which barely separate the two rows of numerous (seven) rough arm spines. Two genital openings in each interbrachial space.

Species of *Ophiocentrus* not herein described.

Ophiocentrus aculeatus, Ljn., Öph. Viv. Öf. Kong. Akad., p. 321, 1866.
Between Batavia and Singapore.

Ophiocoma.

Ophiocoma, Agas., Mem. Soc. Sci. Nat. Neuchatel, 1835.

Disk granulated. Radial shields covered. Teeth, and mouth papillæ, and very numerous close-set tooth papillæ, arranged in a vertical clump. Spines, usually from four to six; smooth, solid (except in *Ophiocoma nigra*). One or two tentacle scales. Two genital openings, beginning outside the mouth shield.

Under the disk granulation is a smooth scale coat, very fine toward the centre; coarser towards the border, where runs a marginal belt of much larger scales connecting the outer ends of the radial shields (Pl. XLII. fig. 9, *l*), which are oblong, with protruding corners. They are continued inward by a broad stripe of large, strongly overlapping scales, a feature nowhere so developed as in this genus. The genital plate is like a thick blade, with rounded edges and a slightly clubbed head for articulating with the radial shields, and to whose side is attached a short, thin blade-like genital scale (fig. 12, *l,n,o*). As seen from above, the arm bones are of very simple structure, being short, with thin, flat, plain-edged wings, and destitute of any forward projections from the upper surface. Their outer and inner faces are of a high type, having the articulating peg and other details well marked (figs. 10, 11). The mouth angles are compactly built and of moderate size, without flaring wings, or high crests, thus differing greatly from *Ophiophrag-*

mus wurdemani; with which, however, they share the peculiarity of having, on the interbrachial sides of the mouth frames, a series of deep furrows for the attachment of the exterior mouth frame muscle. The nerve-ring is scarcely covered by the linear, narrow, peristomial plate, which is in two pieces. A good example of detail of finish is found in the mouth angle, as seen in profile (fig. 13). There are the mouth papillæ (*d*) an even row; and above them, in a close clump, the tooth papillæ (*d'*); and, still above them, the teeth (*d''*) which have a quasi-enamelled grinding end. They are supported by a well-marked jaw-plate (*e*) which has little pits above and cross furrows below, for the insertion of the minute tooth, and tooth papillæ muscles. Outside this are the sockets of the mouth tentacles, whereof the upper one has a fixed scale, and the lower may be said to have the outermost mouth papilla as its scale. Outside these, again, may be seen the wing of the mouth frames (*f*), whose opposite face bears the muscle furrows already referred to.

Some good specific characters may be found in the internal structure. Thus *Ophiocoma æthiops* is distinguished from *Ophiocoma riisei* and *Ophiocoma echinata* by a finer scaling of the central disk (six in the length of 1 mm.), and by larger supplementary scales to the radial shields. *Ophiocoma erinaceus* has the corresponding disk scaling much coarser (three in 1 mm.) than in *Ophiocoma scolopendrina* (five in 1 mm.), and the jaw cover of the latter, though narrow, is thick and well marked. *Ophiocoma pumila*, which leads a group with long arms and a more delicate structure, has large radial shields without the usual projecting corners, while their radiating rows of thick, overlapping scales are almost wanting. The marginal scale belt, however, is well developed. *Ophiocoma pica* has an even but coarse scaling (two in 1 mm. near centre of disk); the radial shields, narrower than in other species, are continued towards the centre by a narrow row of supplementary scales; the genital plate is prolonged, by upright scales, to the mouth shield.

On the borders of this genus lie *Ophiocoma papillosa* and the old species *Ophiocoma nigra.* The former I should doubtless refer to *Ophiopteris* were I sure that it truly corresponded with its type-species *Ophiocoma antipodum.* It differs from *Ophiocoma* (1) in having only three narrow mouth papillæ on each side, and more numerous tooth papillæ; (2) in having small scale spines overlapping the base of the upper arm spine [but this is found in *Ophiocoma canaliculata*]; (3) *Ophiocoma papillosa* (and presumably *Ophiocoma antipodum*) has papillose tentacles; (4) and almost no striations for muscle attachment on the interbrachial sides of the mouth frame wings; (5) in well developed jaw-covers, which, however, are not larger than in *Ophiocoma nigra.* Otherwise, the inner structure, as well as the outer in *Ophiocoma papillosa* is the same as in *Ophiocoma.* As to *Ophiocoma nigra* it differs from the genus in its large and thick peristomial plate, and in having hollow arm spines, which last peculiarity draws it towards *Ophioconis.* Its relations to *Ophiocoma miliaria* and *Ophiocoma antarctica* will be shown by the following table:—

	Ophiocoma miliaria.	*Ophiocoma antarctica.*	*Ophiocoma nigra.*
Peristomial plate.	Thin, in three pieces, with a crust over outer open angle as in *Ophiocamax.*	Thick, in one or two pieces as in *Ophiacantha.*	Thick, in two pieces.
Spines.	Hollow, round, standing on outer edge of side arm plate.	Hollow, round, standing on outer edge of side arm plate, but at an angle.	Hollow, somewhat flat on sides of side arm plate, and at a right angle to arm.
Radial shields.	Rounded.	Small, narrow, no scale rows in any of the three species.	Scapula shape.
Genital plate and scale.	Plate flattened, with longish head. Scale long and blade shape.	The same.	The same.
Teeth and tooth papillæ.	Teeth simple.	Teeth with few tooth papillæ.	Teeth and many tooth papillæ as in true *Ophiocoma.*
Arm bones.	Thin rim; faces normal about as in *Ophiocoma.*	The same.	The same.

As well as I can judge from description and figures and my own notes, *Ophioconis forbesii* would be of the same genus as *Ophiocoma miliaria.* *Ophiocoma antarctica* differs in having arm spines at somewhat of an angle; different peristomial plate and a few tooth papillæ. *Ophiocoma nigra* differs as does *Ophiocoma antarctica,* and also in numerous tooth papillæ, and in spines at a right angle to the arm; being in these two respects a true *Ophiocoma.* All three species agree in—(1) hollow spines, (2) genital plates, &c., (3) arm bones, (4) disk scaling and outer granulation. *Ophiocoma nigra* differs from *Ophiocoma* in hollow spines; in peristomial plate, and in radial shield without any scale lines.

See Plate XLII. figs 9–13.

Table of Species of *Ophiocoma.*

Two tentacle scales.

- Arm spines ringed with darker and lighter, ... *Ophiocoma scolopendrina.*
- Arm spines not ringed. Central disk scales much coarser and thicker than in the preceding, ... *Ophiocoma erinaceus.*
- Doubtful species, ... *Ophiocoma wendtii.* / *Ophiocoma schoenleini.*
- Upper arm spine swollen. Upper arm plates narrow. Mouth shields squarish, ... *Ophiocoma echinata.*
- Disk closely and finely granulated above and below (in other species scattered, and almost none below). Upper arm plates regular and clean cut, . *Ophiocoma brevipes.*
- Doubtful species, ... *Ophiocoma squamata.*
- Arm spines regular, tapering, and pointed. Coloration variegated, . . *Ophiocoma pica.*

Table of Species of *Ophiocoma*—continued.

One tentacle scale.

- At base of arm, sometimes two tentacle scales. Upper arm plates wide, . *Ophiocoma æthiops.*
- Mouth shields elongated. Upper arm plates narrow, . . . *Ophiocoma riisei.*
- First or second arm spine longest. Arms longer and structure lighter than in preceding species, ... } *Ophiocoma pumila.*
- Third and fourth arm spines longest, similar to preceding, . . . *Ophiocoma valenciæ.*
- Similar to preceding, but arms narrower, and mouth papillæ and tentacle scales less stout, ... } *Ophiocoma alexandri.*

Some arm spines flattened like a spatula, ... *Ophiocoma canaliculata.*

Tooth papillæ very numerous. An extra scale spine at base of upper arm spine. Tentacles papillose. [Belongs with *Ophiopteris*?], ... } *Ophiocoma papillosa.*

Arm spines hollow as in *Ophiacantha*, but having otherwise the characters of *Ophiocoma*.

- } *Ophiocoma nigra.*
- Arm spines doubtless hollow, as it is very close to *Ophiocoma nigra.* } *Ophiocoma raschii.*

Ophiocoma scolopendrina, Agas. (Pl. XLVII. fig. 3).

Ophiocoma Scolopendrina, Agas., Mem. Soc. Sci. Nat. Neuchatel, vol. i. p. 192, 1835; Müll and Tr., Wieg. Archiv, vol. vi. p. 328, 1840; Syst. Ast., p. 101; Ltk., Addit. ad Hist., part 2, p. 163; Lym., Ill. Cat. Mus. Comp. Zool., No. i. p. 87; Ludwig, Anatomie der Ophiuren, Zeits. für Wissen. Zoologie, vol. xxxi. p. 241.

Ophiura scolopendrina, Lmk., Hist. Anim. sans Vert., vol. ii. p. 544, 1816.

Ophiocoma molaris, Lym., Proc. Bost. Soc. Nat. Hist., vol. viii. p. 79, 1861.

Ophiocoma alternans (young?), V. Mart., Oph. Ind. Oc. Wieg. Archiv, vol. xxxvi. p. 251, 1870; Lym., Bull. Mus. Comp. Zool., vol. iii., part 10, p. 225.

So many variations in colour, length of arms, and character of spines are found, that Dr. Ludwig was impelled to combine it with *Ophiocoma erinaceus*. The two are however distinguished by the large central disk scales of the latter. The position of the interior organs is figured in Plate XLVII.

Simons Bay, Cape of Good Hope; 10 to 20 fathoms. Tongatabu Reefs; 18 fathoms. Samboangan Bank; Zebu Reefs, Philippines, Fiji Islands.

Ophiocoma erinaceus, Müll. & Tr., Syst. Ast., p. 98, 1842; Ltk., Addit. ad Hist., part 2, p. 164; Lym., Ill. Cat. Mus. Comp. Zool., No. i. p. 85.

Ophiocoma tartarea, Lym., Proc. Bost. Soc. Nat. Hist., vol. viii. p. 78, 1861.

Honolulu Reefs; Samboangan Bank.

Ophiocoma echinata, Agas. (Pl. XLII. figs. 12, 13).

Ophiocoma echinata, Agas., Mem. Soc. Sci. Nat. Neuchatel, vol. i. p. 192, 1835; Lym. Ill. Cat. Mus. Comp. Zool., No. i. p. 81, fig. 5.
Ophiura echinata, Lmk., Hist. Anim. sans Vert., vol. ii. p. 543, 1816.
Ophiura crassispina, Say, Journ. Phil. Acad., vol. v. p. 147, 1825.
Ophiocoma crassispina, Müll. & Tr., Syst. Ast., p. 103, 1842; Ltk., Addit. ad Hist., part 2, p. 142, pl. iv. fig. 7, 1859.
Ophiocoma serpentaria, Müll. & Tr., Syst. Ast., p. 98.
Ophiocoma tumida, Müll. & Tr., Syst. Ast., p. 100.

West Indies.

Ophiocoma pica, Müll. & Tr., Syst. Ast., p. 101, 1842; Lym., Ill. Cat. Mus. Comp., No. i. p. 90.

Ophiocoma lineolata, Müll. & Tr., Syst. Ast., p. 102, 1842.
Ophiocoma sannio, Lym., Proc. Bost. Soc. Nat. Hist., vol. viii. p. 81, 1861.

Ternate Shore.

Ophiocoma pumila, Ltk., Vid. Meddel., Jan. 1856, p. 13; Addit. ad Hist., part 2, p. 14, pl. iv. fig. 5; Lym., Ill. Cat. Mus. Comp. Zool., No. i. p. 71.
Young; Bermudas.

Species of *Ophiocoma* not herein described.

Ophiocoma wendtii, Müll. & Tr., Syst. Ast., p. 99, 1842; Lym., Ill. Cat. Mus. Comp. Zool., No. i. p. 70, note. (Doubtful species.)
South Sea.

Ophiocoma schoenleinii, Müll. & Tr., Syst. Ast., p. 99, 1842; Lym., Ill. Cat. Mus. Comp. Zool., No. i. p. 70, note. (Doubtful species).
Celebes.

Ophiocoma riisei, Ltk., Vid. Meddel., Jan. 1856, p. 14; Ltk., Addit. ad Hist., part 2, p. 143, pl. iv. fig. 6; Lym., Ill Cat. Mus. Comp. Zool., No. i. p. 76.
West Indies.

Ophiocoma æthiops, Ltk. (Pl. XLII. figs. 9–11).

Ophiocoma æthiops, Ltk., Addit. ad Hist., part 2, p. 145, 1859; Lym., Ill. Cat. Mus. Comp. Zool., No. i. p. 78; VII., Trans. Conn. Acad., vol. i., part 2, p. 258.

West Coast of Central America; Lower California.

Ophiocoma brevipes, Pet., Wieg. Archiv, p. 85, 1852; Lym., Ill. Cat. Mus. Comp. Zool., No. i. p. 92; Bull. Mus. Comp. Zool., vol. iii., part 10, p. 225.

Ophiocoma insularia, Lym., Proc. Bost. Soc. Nat. Hist., vol. viii. p. 80, 1861; Ill. Cat. Mus. Comp. Zool., No. i. p. 89; Bull. Mus. Comp. Zool., vol. iii., part 10, p. 225.

Ophiocoma ternispina, V. Martens, Oph. Ind. Oc. Wieg. Archiv, vol. xxxvi. p. 252, 1870; Lym., Bull. Mus. Comp. Zool., vol. iii., part 10, p. 225.

Ophiocoma variegata (?) E. A. Smith, Ann. Mag. Nat. Hist., vol. xviii. p. 39, 1876; Phil. Trans. Roy. Soc., vol. clxviii. p. 565, pl. li. figs. 2–2.

Ophiocoma brevispinosa (?), E. A. Smith, Ann. Mag. Nat. Hist., vol. xviii. p. 40, 1876; Phil. Trans. Roy. Soc., vol. clxviii. p. 556, pl. li. figs. 1–1.

Great Ocean.

Ophiocoma squamata, Agas., Mem. Soc. Sci. Nat. Neuchatel, vol. i. p. 193, 1835; Müll. & Tr., Syst. Ast., p. 102; Lym., Bull. Mus. Comp. Zool., vol. iii., part 10, p. 225.

Ophiura squamata, Lmk., Hist. Anim. sans Vert., 1816, vol. ii. p. 545 (non Delle Chiaje). (Doubtful species.)

Atlantic Ocean.

Ophiocoma nigra, Müll. & Tr., Wieg. Archiv, p. 328, 1840; Syst. Ast., p. 100; Lym., Ill. Cat. Mus. Comp. Zool., No. i. p. 81; Ludwig, Anatomie der Ophiuren, Zeits. für Wissen. Zoologie, vol. xxxi. p. 241.

Asterias nigra, Abildgaard in Müll. Zool. Dan., pl. xciii., 1789.

Asterias sphærulata (?), Pennant, Brit. Zool., vol. iv. p. 63, 1777, pl. xxxii. fig. 63.

Ophiocoma granulata, Fbs. (non Linck), Brit. Starfishes, p. 50.

Ophiocoma Nilsonii, Müll. & Tr., Syst. Ast., p. 100, 1842.

North European Seas.

Ophiocoma raschii, G. O. Sars, Vid. Selsk. Forh., p. 39. 1872.
Norway; 100 fathoms.

Ophiocoma canaliculata, Ltk., Addit. ad Hist., part 3, pp. 46 and 99, 1869.
Bass's Strait; Australia.

Ophiocoma valenciæ, Müll. & Tr. Syst. Ast., p. 102, 1842; Lym., Ill. Cat. Mus. Comp. Zool., No. i. p. 71.
Great Ocean.

Ophiocoma alexandri, Lym., Proc. Bost. Soc. Nat. Hist., vol. vii. p. 256, 1860; Ill. Cat. Mus. Comp. Zool., No. i. p. 74; VII., Trans. Conn. Acad. vol. i., part 2, p. 259.
West Coast of Central America; Lower California.

Ophiocoma papillosa, Lym., Ill. Cat. Mus. Comp. Zool., No. viii., part 2, p. 11, 1875. Lower California; 22 fathoms.

Ophiarachna.

Ophiarachna, Müll & Tr., Syst. Ast., 1842.

Disk granulated. Radial shields covered. Teeth, and mouth papillæ, and very numerous close-set tooth papillæ, arranged in a vertical clump. Spines, usually from four to six; smooth and solid. One or two tentacle scales. Two genital openings, beginning outside the mouth shield, which has, outside and joining it, a supplementary shield.

As might be expected, from its external appearance, the skeleton of this genus is much like that of *Ophiocoma*, except that the peristomial plate is quite large and thick, and composed of three pieces, whereof the two largest form an open angle which is closed by the third.

Species of *Ophiarachna* not herein described.

Ophiarachna incrassata, Müll. & Tr., Syst. Ast., p. 104, 1842; Ltk., Addit. ad Hist., part 3, p. 33; Lym., Bull. Mus. Comp. Zool., vol. iii., part 10, p. 221; Ludwig, Anatomie der Ophiuren Zeits. für Wissen. Zoologie, vol. xxxi. p. 241.

Ophiura incrassata, Lmk., Hist. Anim. sans Vert., vol. ii. p. 542, 1816.
Ophiocoma ocellata, V. Mart., Monatsb. König. Akad. Berlin, p. 345, 1867.

Great Ocean.

Ophiarachna affinis, Ltk., Addit. ad Hist., part 3, pp. 34 and 98, 1869; Lym., Bull. Mus. Comp. Zool., vol. iii., part 10, p. 221.

Fiji Islands.

Ophiarachna armata, Troschel, Sitz. niederrhein. Gesell. in Bonn., p. 137, March 1879.

Mauritius.

Ophiarthrum.

Ophiarthrum, Pet., Monatsb. König. Akad. Berlin, 1851.

Disk quite naked. Radial shields covered. Teeth, mouth papillæ, and very numerous close-set tooth papillæ, arranged in a vertical clump. Spines usually from four to six; smooth, and solid. One or two tentacle scales. Two genital openings, beginning outside the mouth shield.

This genus is essentially an *Ophiocoma* whose skin is but feebly calcified, and the disk is therefore destitute of external granulation and even of scales. In its substance

there may be found, however, minute, loose, perforated lime scales, and its under side is supported by radial shields, and by radiating and marginal scale lines similar to those of *Ophiocoma* but much smaller. The resemblance is carried out in the peristomial plate and the arm bones. The genital plate has a long, clubbed, articulating head, with a thin, long, blade-like, grooved scale attached inside its end.

Species of *Ophiarthrum* not herein described.

Ophiarthrum elegans, Pet., Monatab. Köng. Akad. Berlin, 1851, p. 464; Wieg. Archiv, p. 82, 1852.

Great Ocean.

Ophiarthrium pictum, Lym., Bull. Mus. Comp. Zool., vol. iii., part 10, p. 225, pl. vii. figs. 2–4, 1874.

Ophiocoma picta, Müll. & Tr., Syst. Ast., p. 102, 1842.
Ophiura picta, Kuhl. u. V. Hasselt., MS.

Pelews; Philippines; Java.

Ophiomastix.

Ophiomastix, Müll. & Tr., Syst. Ast., 1842.

Disk nearly smooth or set with small spines, or with spines and grains. Radial shields covered. Teeth and mouth papillæ, and very numerous close-set tooth papillæ, arranged in a vertical clump. Arm spines few (three to four), smooth, solid; the upper one being usually club-ended and more or less clavate. Two genital openings, beginning outside the mouth shield.

In general internal structure this genus is similar to *Ophiocoma*, except that the radial shields are proportionately larger, the wings of the mouth frames more approached in the interbrachial space, and the genital plate more rounded and longer. As to scaling the disk varies much. Thus, in *Ophiomastix venosa*, the scales are minute and thin (nine in the length of 1 mm. at centre of disk), while *Ophiomastix annulosa* has them larger and lumpy (two to three in 1 mm.).

TABLE OF SPECIES OF *Ophiomastix.*

Two tentacle scales.	Disk beset on both sides with long thin spines. Under arm plates squarish, ...	*Ophiomastix annulosa.*
	Disk with spines as in the preceding. Under arm plates much wider than long, ...	*Ophiomastix caryophyllata.*
	Disk closely beset with grains and spines, . . .	*Ophiomastix mixta.*
	A few spines on upper disk. Upper arm spine not club-shape. One tentacle scale much smaller than the other, . .	*Ophiomastix janualis.*

Table of Species of *Ophiomastix*—continued.

One tentacle scale.	Usually one, rarely two tentacle scales. Disk scaling obscured by thick skin; a few blunt spines on upper disk, . .	*Ophiomastix venosa.*
	Disk densely beset with very short spines, . . .	*Ophiomastix asperula.*
No tentacle scale.	Disk scales and upper and side arm plates obscured by thick skin. A few small spines on upper disk, ...	*Ophiomastix flaccida.*

Ophiomastix caryophyllata, Ltk., Addit. ad Hist., part 3, pp. 43 and 99, 1869; Lym., Ill. Cat. Mus. Comp. Zool., No. vi. p. 15, 1871.

Fiji Islands; Zebu Reefs.

Ophiomastix mixta, Ltk., Addit. ad Hist., part 3, pp. 44 and 99, 1869; Lym., Ill. Cat. Mus. Comp. Zool., No. vi. p. 15.

Fiji Islands.

Species of *Ophiomastix* not herein described.

Ophiomastix annulosa, Müll. & Tr., Syst. Ast., p. 107, 1842; Ltk., Addit. ad Hist., part 3, p. 44; Lym., Ill. Cat. Mus. Comp. Zool., No. vi. p. 15.

Ophiura annulosa, Lmk., Hist. Anim. sans Vert., vol. ii. p. 543, 1816.

Java; Philippines; Pelews.

Ophiomastix venosa, Pet., Weig. Archiv, p. 83, 1852; Ltk., Addit. ad Hist., part 3, p. 44, 1869; Lym., Ill. Cat. Mus. Comp. Zool., No. vi. p. 15.

Mozambique.

Ophiomastix asperula, Ltk., Addit. ad Hist., part 3, pp. 44 and 99, 1869; Lym., Ill. Cat. Mus. Comp. Zool., No. vi. p. 15.

Fiji Island.

Ophiomastix janualis, Lym., Ill. Cat. Mus. Comp. Zool., No. vi. p. 14, pl. i. figs. 13, 14, 1871.

Ophiomastix flaccida, Lym., Bull. Mus. Comp. Zool., vol. vi. p. 227, pl. vi. figs. 14, 15, 1874.

Acantharachna mirabilis, E. A. Smith, Journ. Linn. Soc., vol. xiii. p. 335, pl. xviii. figs. 1–6, 1877.

Philippines; 7 fathoms.

Ophiopteris.

Ophiopteris, E. A. Smith, Ann. Mag. Nat. Hist., 1877.

Disk granulated. Radial shields covered. Mouth angle small and short with a few small, spaced mouth papillæ. Tooth papillæ very numerous and arranged in a close vertical clump somewhat as in *Ophiothrix*. Four teeth. Spines smooth and solid; the upper one having one or two supplementary scale-like spines applied at its base. One tentacle scale. Two genital openings beginning outside the mouth shields.

For remarks on internal structure, see near the end of *Ophiocoma*.

Species of *Ophiopteris* not herein described.

Ophiopteris antipodum, E. A. Smith, Ann. Mag. Nat. Hist., p. 305, 1877.
New Zealand.

Ophiochiton.

Ophiochiton, Lym., Bull. Mus. Comp. Zool., 1878.

Disk covered with fine, imbricated scales and small radial shields. Numerous sharp mouth papillæ, with teeth but no tooth papillæ. Upper and under arm plates about as broad as long, and separating the side arm plates, which project slightly and are rather small. Under plates furnished with a median longitudinal ridge. Arm spines slender and smooth, arranged on the sides of the side arm plates, near the outer edge. Two long genital openings in each interbrachial space.

The genus is allied to the true *Ophiarachna*, which, however, has a granulated disk.

Ophiochiton fastigatus, Lym. (Pl. XXIV. figs. 13–15).

Ophiochiton fastigatus, Lym., Bull. Mus. Comp. Zool., vol. v., part 7, p. 132, pl. vii. figs. 182, 183, 1878.

Four slender, smooth, tapering, blunt arm spines. Scaling of disk very fine, with a few larger rounded plates. Radial shields small and separated. About thirteen mouth papillæ to each angle.

(Type specimen from Station 232).—Diameter of disk 20 mm. Width of arm, without spines, close to the disk 2·8 mm. Five or six sharp-pointed papillæ on each side of an angle, and one shorter and more rounded at the apex. Mouth shields much broader than long, with lateral corners rounded, a peak within and a lobe without; length to breadth, 2·3 : 3. Side mouth shields very narrow, broader without than within, where they meet. First under arm plate very small, triangular; the other plates are four sided, with outer and inner edges nearly straight, and deep re-entering curves on the lateral

sides: they are highly arched, forming along the arm a longitudinal ridge. Side arm plates small, with a rather low spine ridge, not meeting below or above. Upper arm plates broader than long, slightly arched, four sided, broader without than within; inner and lateral sides straight, outer edge slightly curved. Disk flat, with interbrachial spaces somewhat contracted, covered above and below by very minute, thin, overlapping scales; three to five in the length of a millimetre, and somewhat larger near margin. In each brachial space there is a row of small rounded scattered plates radiating from the central primary plate; genital scales covered. Radial shields widely separated, long triangular, and small, with an angle within; length to breadth, 2 : 1. Four smooth, tapering, blunt, nearly cylindrical arm spines, placed high on the sides of side arm plates near the outer edge; lengths to that of an arm joint, 1·8, 1·8, 1·8, 2 : 1·3. Two tentacle scales on each pore, one large one on the interbrachial and a smaller one on the brachial side. Colour in alcohol, pale brown; upper disk inclining to olive.

A smaller specimen with a disk of 13 mm. had arms 70 mm. long. It was similiar to the adult, except that there usually were but three arm spines, and the second and third mouth papillæ from corner of mouth slit were flat and blunt.

Station 232.—May 12, 1875; lat. 35° 11′ N., long. 139° 28′ E.; 345 fathoms; sandy mud.
Station 191.—September 23, 1874; lat. 5° 41′ S., long. 134° 4′ E.; 800 fathoms; mud.

Ophiochiton lentus, Lym. (Pl. XXIII. figs. 16–18).

Ophiochiton lentus, Lym., Bull. Mus. Comp. Zool., vol. vi. pt. 2, p. 55, pl. xiv. figs. 398–400, 1879.

Three stout arm spines. Under arm plates thickened, but not forming a distinct ridge. Scaling of disk smooth and uniform.

(Type specimen from Station 171.)—Diameter of disk 13 mm. Width of arm close to disk 2·5 mm. There are eleven short, sharp, stout, close-set mouth papillæ on each angle, the two outermost and the one at the apex being a little larger than the rest. Mouth shields about as broad as long, of a rounded heart shape. Side mouth shields extremely narrow, bent, wider without than within, where they meet. Under arm plates large, swollen but not ridged, wider without than within, with lateral sides re-enteringly curved. Side arm plates short and stout, with a low thick spine edge. Upper arm plates twice as broad as long, of a fan shape, with inner arm truncated, or a diamond shape with much rounded angles. Disk round, smooth and flat, covered with small, pretty, uniform, rounded, overlapping scales, two or three in the length of 1 mm. Radial shields small, twice as long as broad, with much rounded corners, separated their entire length by two large round scales; length to breadth, 2 : 1. Interbrachial spaces below covered with scaling similar to but finer than that above. Genital openings long, extending from outer corners of mouth shield, where there are a few minute papillæ, to margin of disk. Three stout, blunt, cylindrical, tapering, nearly equal arm spines, about as long as an arm joint. Two round, flat, tentacle scales on the side arm plate,

whereof the one next the under arm plate is much the smaller. Colour in alcohol pale grey.

Station 171.—July 15, 1874; lat. 28° 33′ S., long. 177° 50′ W.; 600 fathoms; rock.

The following four genera are allied. *Ophiacantha* is distinguished by the delicate scales and slender radial shields obscured by skin; *Ophiothamnus*, by its wide naked radial shields, and by the peculiar jaw cover of three symmetrical pieces; *Ophiomitra* by the coarse disk plates and scales, and wide naked radial shields; and *Ophiocamax* by the tufts of numerous spiniform mouth and tooth papillæ, and the scales of the mouth tentacles borne on a special plate. The old genus *Ophiacantha* embraces the greatest variety of forms, from *Ophiacantha bidentata* and *Ophiocantha vivipara*, which come near *Ophiocoma*, to the delicate *Ophiocoma pentacrinus*, with its thorny, translucent arm spines and its knotted arms.

Ophiacantha.

Ophiacantha, Müll. & Tr. Syst. Ast., 1842.

Disk somewhat thick and swollen and clad in a thin skin, that more or less obscures the underlying even coat of fine imbricated scales, which sometimes completely covers the long narrow radial shields, and bears spines, thorns, or rough grains. No tooth papillæ. Mouth angle rather large and bearing numerous (7–16) sharp, rather long, papillæ. Teeth sharp and elongated. Arm spines hollow, numerous (4–11); usually rough or thorny. Side arm plates large, and nearly or quite meeting above and below. Two genital openings in each brachial space.

From its under side the disk scaling is seen to be thin and usually uniform. It is supported by long narrow, bar-like radial shields, whose outer end is but little enlarged where it joins the thick, club-headed, somewhat rounded genital plate, to which is attached a short, blade-like scale. The arm bones are wider than high, and have thin simple wings whose margins are not grooved. Their outer and inner faces are of the typical form, and have the lower canal like a small, nearly-closed notch. The mouth angles are stout and compact, and the tops of the mouth frames wide, a portion being covered by the thick, rounded, rather large peristomial plate, which is in a single piece.

A comparison of species shows some good specific differences resting on internal structure, and some divergence from the generic type. Thus *Ophiacantha abnormis* has both jaw and peristomial plate exceptionally narrow, while the radial shield is wide and thin, and the genital scale much longer than is usual. *Ophiacantha vivipara* and *Ophiacantha granulosa* have their radial shields prolonged inward by lines of imbricated, supplementary scales, thus showing a slight approach to *Ophiocoma*.

See Plate XLI. figs. 12–14.

Table of Species of *Ophiacantha*.

Disk closely beset with grains or minute tubercles. Arm spines smooth.	Four arm spines. Disk minutely tuberculous,	*Ophiacantha tuberculosa.*
	Seven slender translucent arm spines. Some smooth spines on disk,	*Ophiacantha vepratica.*
	Ten arm spines. Outer ends of radial shields naked,	*Ophiacantha granulosa.*
Disk closely beset with short smooth stout spines, sometimes mingled with grains. Arm spines not thorny.	Spines and grains on disk; outer ends of radial shields naked; numerous (16) mouth papillæ,	*Ophiacantha sertata.*
	Eight arm spines; outer ends of radial shields naked,	*Ophiacantha spectabilis.*
	Eleven arm spines. Radial shields covered,	*Ophiacantha rosea.*
Disk beset with small short stumps or grains, more or less thorny. Arm spines stout, opaque, and scarcely thorny.	Seven mouth papillæ in adult, and eleven or twelve arm spines. Six or seven arms,	*Ophiacantha vivipara.*
	Large tentacle scale. Five arms; seven or eight arm spines,	*Ophiacantha bidentata.*
	Large tentacle scale. Five arms; six arm spines; a lozenge like raised figure at inner end of under arm plate,	*Ophiacantha placentigera.*
	Large tentacle scale; six arms; seven arm spines,	*Ophiacantha anomala.*
	Slender tentacle scale; six arm spines,	*Ophiacantha imago.*
Disk evenly granulate.	Seven long, slender, much flattened arm spines. Outer mouth papilla spatula shaped,	*Ophiacantha valenciennsi.*
Disk beset with short slender spines.	Disk spines with forked heads, and covered with thick skin. Arm spines scarcely or not at all thorny. One minute short tentacle scale,	*Ophiacantha sentosa.*
	Disk spines simple. Arm spines not thorny. One or two large, long tentacle scales,	*Ophiacantha stimulea.*
	Disk spines with forked heads. Arm spines slender and thorny,	*Ophiacantha echinulata.*
	Spines of disk and arms slender and translucent. Arm spines not thorny. Some thorny stumps on disk,	*Ophiacantha segesta.*
	Mouth angles elongated, and bearing twelve to fourteen papillæ. — Arm spines flattened and serrated on edges,	*Ophiacantha hirsuta.*
	Mouth angles elongated, and bearing twelve to fourteen papillæ. — Arm spines smooth, rounded, slender, tapering,	*Ophiacantha abnormis.*
Disk beset with small spines or grains. Radial shields making narrow radiating ridges; arms long (8–12 times diameter of disk).	Disk beset with stout spines, essentially smooth, and with grains. Arms about twelve times diameter of disk. Radial shields partly naked,	*Ophiacantha troscheli.*
	Disk beset with thorny grains and spines. Radial shields covered,	*Ophiacantha setosa.*
	Disk beset with thorny grains and spines over its whole surface. Radial shields covered,	*Ophiacantha smitti.*

Table of Species of *Ophiacantha*—continued.

Disk beset with thorny stumps or crotchets. Numerous (6–11) translucent arm spines.

Mouth papillæ long and slender. — About eleven mouth papillæ to each angle; large tentacle scales,	*Ophiacantha cuspidata.*
Mouth papillæ long and slender. — Seven mouth papillæ to each angle; slender spiniform tentacle scales,	*Ophiacantha longidens.*
Mouth papillæ long and slender. — Seven mouth papillæ. High disk stumps with thorny sides and ends. Arm spines feebly thorny. Six arms,	*Ophiacantha nodosa.*
The lowest arm spine thickened and curved,	*Ophiacantha cornuta.*
Tentacle scales with long thorns; arm spines strongly thorny,	*Ophiacantha aspera.*
Nine rather short, scarcely thorny arm spines. Side arm plates barely meeting above and not prominent, so that the upper arm spines on either side are widely separated. Disk crotchets close-set and rather coarse,	*Ophiacantha indica.*
Seven strongly thorny arm spines. Side arm plates very prominent. Coarse disk crotchets,	*Ophiacantha stellata.*
Arm spines strongly thorny; tentacle scales long, stout, and sharp,	*Ophiacantha scutata.*
Eight or more feebly thorny arm spines; side arm plates not very prominent. Disk crotchets rather stout,	*Ophiacantha cosmica.*
Ten slightly thorny arm spines, longer than in *Ophiacantha cosmica*,	*Ophiacantha millespina.*
Seven to eight slender, nearly smooth arm spines. One narrow spine-like tentacle scale. Under arm plates much wider than long of a broad axe-shape,	*Ophiacantha discoidea.*
Seven scarcely thorny arm spines; side arm plates very prominent. Disk crotchets minute,	*Ophiacantha pentacrinus.*
Six not thorny, rather short arm spines; side arm plates not very prominent. Disk crotchets fine and close-set,	*Ophiacantha abyssicola.*
Very long, not thorny arm spines; side arm plates large and swollen; outer side of under arm plates strongly curved,	*Ophiacantha levispina.*
Disk evenly set with minute bifid or trifid stumps. Four to five sharp, slightly rough, glassy arm spines, not as long as a joint,	*Ophiacantha dallasi.*
Disk beset with minute grain-like stumps bearing a crown of blunt thorns. Arm spines long, slender, translucent, and thorny, mounted on very projecting side arm plates which meet above,	*Ophiacantha serrata.*
Disk covered with soft skin, through which a fine scaling may be distinguished; and set above with a few pointed, rough, stout spines. On each angle, eleven scattered spine-like mouth papillæ. Three slender, nearly smooth, rounded, tapering arm spines,	*Ophiacantha marsupialis.*

Ophiacantha tuberculosa, Lym. (Pl. X. figs. 1–3).

Ophiacantha tuberculosa, Lym., Bull. Mus. Comp. Zool., vol. v., part 7, p. 137, pl. viii. figs. 204, 205, 1878.

Disk wrinkled and beset with coarse grains; four smooth stout arm spines.

(Type specimen from Station 210.) Diameter of disk 6·5 mm. Length of arm 32 mm. Width of arm without spines 2 mm. Seven stout blunt mouth papillæ, whereof the innermost is spearhead-shaped and stands under the teeth, which are four in number, flat and square, with rounded corners. Mouth shields small, much wider than long, with an obtuse angle within and a little peak without; length to breadth, ·8 : 1. Side mouth shields short, nearly crescent shape, with the curve outward; scarcely meeting within. Under arm plates thick and distinct, four-sided, somewhat broader than long, with outer side curved and the others nearly straight, except second plate, which is nearly pentagonal, with a very obtuse angle within. Side arm plates slightly projecting, meeting narrowly below and not at all above. Upper arm plates thick and well marked, four sided, with outer corners rounded, much wider without than within. Disk contracted in interbrachial spaces, with deep radiating furrows between the narrow radial shields, which are completely hidden, as well as the disk scales, by the skin and by numerous small conical tubercles, which are larger and closer set on the radial shields. Four stout, blunt, cylindrical, smooth arm spines; upper one much largest; lengths to that of an arm joint, 2, 1·4, 1, 1 : 1. One rather small tentacle scale, longer than wide, pointed, and not encroaching (as is usual in the genus) on the under arm plate. Colour in alcohol; very pale brown.

This species is one of the most aberrant in the genus; the arm spines, smooth, and only four in number, and the minute disk tubercles, instead of thorny grains, remind one rather of *Ophiocoma*. Indeed, *Ophiacantha bidentata* and *Ophiacantha vivipara*, which somewhat resemble this species, have been described under *Ophiocoma*; but the general structure is that of a true *Ophiacantha*.

Station 210.—January 25, 1875; lat. 9° 26′ N., long. 123° 45′ E.; 375 fathoms; mud.

Ophiacantha placentigera, Lym. (Pl. XXVIII. figs. 15–17).

Ophiacantha placentigera, Lym., Anniv. Mem. Bost. Soc. Nat. Hist., pl. ii. figs. 20–22, 1880.

One very large, flat tentacle scale. Six cylindrical, tapering, nearly smooth arm spines. At inner point of each under arm plate is a diamond-shaped raised figure.

Diameter of disk 9·5 mm. Width of arm, close to disk without spines, 2 mm. Five spaced mouth papillæ on each side of mouth angle, the two outermost, large, squarish and flat, the three inner ones more pointed; and the one at the apex short and blunt. Mouth shields broad triangular, with rounded corners, and a blunt angle inward. Side

mouth shields long and large, nearly or quite meeting within, where they taper; broad without where they join the side arm plates and curve somewhat round the mouth shield. Under arm plates of a wide axe-shape, with a curve without, re-entering curves on the lateral sides, and an obtuse angle within. At the innermost point on the median line, is a small raised figure in form of a transverse diamond. Side arm plates wide and thick, meeting fully below, just touching above. Upper arm plates broad diamond shape, with outer and inner angles somewhat rounded, and with a central longitudinal ridge; length to breadth, 1·5 : 2. Disk flat and thick, closely set above with short, thick rounded, thorny stumps, four or five in 1 mm. long, those in the centre being smaller; near the margin they are shorter; and below they take the form of scattered grains. Radial shields small, of a short ovoid shape, widely separated and diverging inward. Six long cylindrical, scarcely rough, slightly tapering arm spines; those above and below shorter than the two middle ones, which are as long as two arm joints. One large, flat, wide, smooth, tooth-like tentacle scale on the outer edge of the side arm plate.

Colour in alcohol, very pale brown.

Station 175, near Fiji Islands.—August 12, 1874; lat. 19° 2′ S., long. 177° 10′ E.; 1350 fathoms; red clay.

Ophiacantha vepratica, Lym. (Pl. XIII. figs. 7–9).

Ophiacantha vepratica, Lym., Bull. Mus. Comp. Zool., vol. v., part 7, p. 137, pl. x. figs. 245–247; Bull. Mus. Comp. Zool., vol. v., part 9, p. 230, 1878.

Disk closely beset with grains, among which are a few short spines. Seven not thorny, translucent, slender arm spines.

(Type specimen from Station 171.) Diameter of disk 6·5 mm. Length of arm about 30 mm. Width of arm without spines 1·8 mm. Mouth papillæ stout, conical, blunt, three on each side of an angle, and a larger odd one at the apex within, which is similar to the five teeth standing immediately above it. Mouth shields small, about as long as broad, bounded within by an obtuse angle, and without by a deep curve or truncated angle; length to breadth, ·8 : 1. Side mouth shields short and rather wide, meeting within. Under arm plates pentagonal, wider than long, with a very obtuse angle inward, sometimes modified as a curve; lateral sides a little re-enteringly curved, and outer side gently curved. Upper arm plates wide fan-shaped, with an angle inward. Side arm plates stout, rather prominent, narrowly meeting above and below, near base of arm. Disk slightly puffed and wrinkled, closely set with small, round, smooth grains, among which, on upper surface, appear a few short stout spines; radial shields and disk scales hidden by skin and by granulation. Seven regular, slender, cylindrical, tapering, not thorny arm spines; lengths to that of an arm joint, 2·8, 2·5, 2, 2, 1·5, 1·3, 1 : ·8. One pointed, rather large tentacle scale. Colour in alcohol, white.

A smaller specimen had a disk 6 mm. in diameter, with grains, but scarcely any spines

on it. A young one had a disk 4 mm. in diameter, and arms 16 mm. long. The disk grains were rough under the microscope; the arm spines were proportionately longer, and the side arm plates more prominent, than in the adult; the outer mouth papilla was larger than its neighbours.

Station 171.—July 15, 1874; lat. 28° 33′ S., long 177° 50′ W.; 600 fathoms; rock.

Ophiacantha granulosa, Lym. (Pl. XIV. figs. 7–9).

Ophiacantha granulosa, Lym., Bull. Mus. Comp. Zool., vol. v., part 7, p. 137, pl. viii. figs. 206–208, 1878.

Disk evenly set with smooth grains; outer ends of radial shields naked; ten smooth slender arm spines.

(Type specimen from Station 201.) Diameter of disk 9 mm. Length of arm 42 mm. Width of arm without spines 3 mm. Seven pointed, rather stout, nearly cylindrical mouth papillæ Seven teeth, flat, with a rounded cutting edge. Mouth shields small, broader than long, with an obtuse angle within, and a curve without; length to breadth, ·8 : 1. Side mouth shields large and wide, broader without than within, where they are slightly separated. Under arm plates much wider than long, of a wide axe-shape, with a curved edge outward, a lobe or a narrow obtuse angle within, and the lateral sides re-enteringly curved. Upper arm-plates rather small, of a wide fan-shape, with an angle inward, and lateral sides re-enteringly curved. Side arm plates large and moderately projecting, meeting broadly above, near base of arm, but scarcely touching below. Disk slightly puffed, closely and evenly set with smooth grains, about four in the length of a millimetre, which hide the fine disk scales, except in the lower interbrachial spaces. Radial shields covered, except their outer ends, which are naked and sunken below the surrounding surface. Ten slender, tapering, cylindrical translucent arm spines, which are not thorny; lengths to that of an arm joint, 3·2, 3·2, 2·2, 2, 2, 2, 1·8, 1·3, 1·3, 1 : 1. One rather small, blunt tentacle scale. Colour in alcohol, pale reddish-brown.

A younger specimen, with a disk 4 mm. in diameter and an arm of 18 mm., presented no special variations, except that there were only eight arm spines, and the under arm plates were proportionately smaller.

Station 201.—October 26, 1874; lat. 7° 3′ N., long. 121° 48′ E.; 82 to 102 fathoms; stones and gravel.

Ophiacantha valenciennesi, Lym. (Pl. XXVI. figs. 7, 8).

Ophiacantha valenciennesi, Lym., Bull. Mus. Comp. Zool., vol. vi., part 2, p. 57, pl. xv. figs. 408–410, 1878.

Disk evenly granulated above. Seven long, slender, much flattened arm spines. Outer mouth papilla spatula-like and covering the pore of the mouth tentacle.

(Type specimen from Station 192.) Diameter of disk 11 mm. Length of arm 50 mm. Width of arm near disk 3 mm. Twelve mouth papillæ to each angle; of these the outermost one on either side is wide, like a short spatula, and is plainly the scale of the mouth tentacle; the next four papillæ are sharp and peg-like, the pair at apex of angle are thickened and conical. Five flat teeth, a little longer than wide, with a curved cutting edge. Mouth shields long heart-shaped, or broad spearhead-shaped; length to breadth, 1·5 : 1·2. Side mouth shields large and three-sided, wide without, tapering inward, where they nearly or quite meet. First under arm plate small and wider than long; plates beyond, wide pentagonal, with outer side gently curved, laterals re-enteringly curved, and inner angle so obtuse and rounded as to be almost a gentle curve. Side arm plates barely meeting below, separated above, rising in a thick abrupt spine ridge. Upper arm plates small, thick, and fan-shaped, with the angle inward. Disk thick and puffed, covered above by an even granulation, nine or ten grains in the length of 1 mm. On removing these, there is disclosed a smooth coat of very thin scales, about five in the length of 1 mm., which cover the radial shields, except their outer ends; interbrachial spaces below without grains, and covered with scales still finer than those above. Seven slender, much flattened arm spines, slightly rough on the edges; the uppermost one extremely long, sometimes equal to five arm joints, diminishing to the lowest, which is longer than one joint. Two large, oblong, slightly pointed tentacle scales. Colour in alcohol, pale brown above, much lighter below.

Station 192.—September 26, 1874; lat. 5° 42′ S., long. 132° 25′ E.; 129 fathoms; mud.

Ophiacantha rosea, Lym. (Pl. XXV. figs. 10–12).

Ophiacantha rosea, Lym., Bull. Mus. Comp. Zool., vol. v., part 7, p. 139, pl. x. figs. 267, 268, 1878.

Disk scales and radial shields hidden by a thick skin, which is closely beset with very short, stout spines, which sometimes are no higher than grains. Eleven arm spines, slightly rough under microscope.

(Type specimen from Station 308.) Diameter of disk 17 mm. Length of arm, 68 mm. Width of arms without spines 4·5 mm. Mouth papillæ irregular; there are usually five on the inner part of the angle, flattened and blunt; and outside these, near end of mouth slit, a group of from three to six irregular papillæ, short and flattened. Eight or nine teeth, shaped like blunt spear heads. Mouth shields and side mouth shields closely joined and covered with thick skin, so that their outlines are not clear. Under arm plates shield shaped, with an angle within, a curve without, and re-entering curves on the lateral sides opposite the large tentacle scales. Upper arm plates with distinct outlines, broad fan shaped, with a rounded or very obtuse angle inward. Side arm plates, near base of arm, barely meeting above and below, and having a narrow

projecting spine ridge Disk puffed, densely and evenly beset, with very short, stout, conical spines, which to the naked eye seem nearly like large grains; scales and radial shields entirely covered. Eleven stout, blunt, regular, cylindrical arm spines, which, under the microscope, are slightly rough. Lengths to that of an arm joint, 3·5, 4·7, 4, 3·8, 3·8, 2·8, 2·5, 2·5, 2·5, 1·2, ·8 : 1·3. One very large, thick, pointed tentacle scale, over 1 mm. long. Colour in alcohol, pale rose-pink above; below yellowish.

Specimen from the distant station 145 differed only in having larger spines on the disk. A young one, with a disk of 7 mm., had only seven mouth papillæ to each angle; the additional papillæ at the outer end of mouth slit had not yet appeared; the disk spines were forked and thorny, and the eight arm spines were rough, and almost thorny.

Station 145.—December 27, 1873; lat. 46° 40′ S., long. 37° 50′ E.; 310 fathoms.
Station 236.—June 5, 1875; lat. 34° 58′ N., long. 139° 30′ E.; 420 to 775 fathoms; mud.
Station 308.—January 5, 1876; lat. 50° 10′ S., long. 74° 42′ W., 175 fathoms; mud.

Ophiacantha vivipara, Ljn. (Pl. XLVI. figs. 7–9).

Ophiacantha vivipara, Ljn., Om Tvänne Nya arter, Öf. Kong. Akad., p. 471, 1870; Lym. Bull. Mus. Comp. Zool., vol. v., part 7, p. 149.
Ophiocoma (?) *vivipara*, Wyv. Thom., Voyage "Challenger," Atlantic, vol. ii. p. 242, fig. 50.

As its name indicates, the species has always been known as viviparous.[1] It carries its young, until they are quite large, in the ovarial bursa (Pl. XLVI. fig. 8, Y), whence they often thrust an arm through the genital opening (*no.*). Plainly this is a mode of reproduction differing greatly in degree from that of the egg-laying species, where we find the ovarial tubes crammed with thousands of small ova. In the viviparous there is no room for such numbers, because the young become so large that a few of them occupy the entire cavity. They are evidently produced in a series. The vertical section at a right angle to an arm, cited above, shows, besides the large young, two embryos in pockets (Y′, Y′), ready to take the place of the larger brood when it quits the mother. The bursæ are pleated bags having lime scales in their substance and adhering to the thickened wall of the digestive cavity (St). They pass upward over the arms; but do not force themselves between the roof of the disk and the digestive cavity, for the upper wall of the latter clings pretty closely to the roof and the under side of the radial shields (*l*, *l*.). A parallel cross cut made close to the edge of the disk (fig. 7) shows two of the bursæ (*δ*,*δ*.) as simple cracks passing upward, and having between them a lobe of the digestive cavity (St) which lies just over an arm. The third bursa (*δ′*) has genital tubes or pockets, which lie over an arm. This section exhibits also one brachial and two interbrachial lobes of the digestive cavity, with their very thick pleated walls. A portion of these, highly magnified (fig. 9) showed rows of elongated oval cells, with long thread-like, or fibrous, or tubular prolongations, the whole resembling the liver cells of

[1] Ljungman, *loc. cit.*; Wyv. Thomson, *loc. cit.*

some invertebrates. In specimens so long macerated in alcohol, it is impossible to speak positively of such structures, but I believe that the function of the thick wall is to secrete a digestive fluid. It should be observed, also, that this soft cell layer may easily be scraped off, leaving the outer thin membranous sac of the digestive cavity. On the floor of the cavity was found a mass containing minute isopods and larvæ of brachyurans.

Marion Island; 50 to 75 fathoms. The following three places in the Kergulen Islands:—Christmas Harbour, 120 fathoms; Balfour Bay, 20 to 60 fathoms; Royal Sound, 25 fathoms. Station 151.—February 7, 1874; off Heard Island; 75 fathoms; mud. Station 313.—January 20, 1876; lat. 52° 20′ S., long. 68° 0′ W.; 55 fathoms; sand. Station 314.—January 21, 1876; lat. 51° 36′ S., long. 65° 40′ W.; 70 fathoms; sand. Station 320.—February 14, 1876; lat. 37° 17′ S., long. 53° 52′ W.; 600 fathoms; hard ground,

Ophiacantha bidentata, Ljn., Dr Goës Oph. p. 652; Lym., Bull. Mus. Comp. Zool., vol. v., part 7, p. 149, 1878.

Asterias bidentata, Retz., Diss., p. 33, 1805.
Ophiura Retzii, Nilsson, Collectanea Zoologiæ Scandinavicæ, p. 15, 1817.
Ophiacantha spinulosa, Müll. & Tr., Syst. Ast., p. 106, 1842; Ltk. Addit. ad Hist., part 1, p. 65, pl. ii. fig. 14; Lym., Ill. Cat. Mus. Comp. Zool., No. i. p. 93, figs. 6, 7.
Ophiocoma arctica, Müll & Tr., Syst. Ast., p. 103.
Ophiacantha grönlandica, Müll. & Tr., Wieg. Archiv, p. 183, 1844.
Ophiocoma echinulata, Fbs., Suth. Journ. Voy. Baffin's Bay, vol. ii. App., p. ccv., 1852.

Dr. Ljungman showed me at Stockholm the original of Retzius, which is, without question, this species.

Station 45.—May 3, 1873; lat. 38° 34′ N., long. 72° 10′ W.; 1240 fathoms; mud. Station 46.—May 6, 1873; lat. 40° 17′ N., long. 66° 48′ W.; 1350 fathoms; mud. Station 49.—May 20, 1873; lat. 43° 3′ N., long. 63° 39′ W.; 83 fathoms; gravel, stones.

Ophiacantha imago, Lym. (Pl. XXV. figs. 4–6).

Ophiacantha imago, Lym., Bull. Mus. Comp. Zool., vol. v., part 7, p. 139, pl. x. figs. 275, 276, 1878.

Disk regularly set with small, short thick stumps, each bearing a crown of blunt thorns; tentacle scales small and pointed; six short opaque, cylindrical, scarcely thorny arm spines.

(Type specimen from Kerguelen Islands.) Diameter of disk 8 mm. Length of arm 37 mm. Width of arm without spines 1·6 mm. Seven short, stout, blunt, close-set mouth papillæ; the innermost are a little the largest. Four flat, rather thick teeth, all squarish, except uppermost one, which is pointed. Mouth shields small, of a rounded

diamond-shape. Side mouth shields short, wide, slightly curved, not meeting within. They and the mouth shield are obscured by a thick skin. Under arm plates somewhat obscured by skin, axe-shaped, with a broad curve without, a narrow angle within, and lateral sides slightly re-enteringly curved. Upper arm plates long triangular, with an acute angle inward and a curve without. Side arm plates large, meeting above and below, with a rounded, rather wide, but not very prominent spine ridge. Disk regularly, but not very closely set with small, short, thick stumps, each bearing a crown of blunt thorns. Radial shields and scaling hidden. Six cylindrical, opaque, blunt, slightly tapering arm spines, which under the microscope, are a little rough, but not thorny; lengths to that of an under arm plate, 3, 2·2, 1·3, 1·2, 1·2, 1 : 1. One minute pointed tentacle scale. A young specimen from the same locality had a disk 4 mm. in diameter, and arms of 18 mm. The disk stumps were closer set, and more like grains, and there were nine mouth papillæ to each angle.

This species is viviparous. It represents in the antarctic zone the arctic *Ophiacantha anomala*, from which it differs in having a minute slender tentacle scale and only five arms.

Christmas Harbour, Kerguelen Islands; 120 fathoms. Royal Sound, Kerguelen Islands; 25 fathoms. Station 150.—February 2, 1874; lat. 52° 4′ S., long. 71° 22′ E.; 150 fathoms; rock. Station 151.—February 7, 1874; off Heard Islands; 75 fathoms; mud. Kerguelen Islands; 120 fathoms.

Ophiacantha sentosa, Lym. (Pl. XIII. figs. 10–12).

Ophiacantha sentosa, Lym., Bull. Mus. Comp. Zool., vol. v., part 7, p. 140, pl. ix. figs. 229–232, 1878.

Disk closely beset with short slender spines, with forked heads, encased in thick skin, so that they give the disk a furry look; arm spines slender and not thorny; one minute rounded tentacle scale.

(Type specimen from Station 298.) Diameter of disk 16 mm. Length of arm 80 mm. Width of arm without spines 3 mm. Mouth papillæ nine or eleven, to each angle of which the innermost odd one is stoutest and spearhead-shaped, and is similar to and continuous with the teeth; the outermost is very small and rounded, and the others are stout, conical, and pointed. Mouth shields small, wider than long; bounded within by an obtuse angle, and without by a curve. Side mouth shields wider without than within, where they meet, of moderate width, and extending well beyond mouth shield on either side. Under arm plates slightly swollen, much wider without, where they are gently curved, than within, where they present a peak, and are separated from the next plate; lateral sides re-enteringly curved opposite tentacle pores. Side arm plates moderately prominent, meeting below, and beyond fourth joint, above also. Upper arm plates about as long as broad, narrow fan-shaped, with an angle inward. Disk puffed,

covered with a thick skin, which obscures the radial shields and scaling, except a patch near mouth shield; the surface is closely set with small spines, about ·8 mm. long, whose ends are forked, but which are more or less cased in skin. Seven regular tapering arm spines, smooth, or bearing a few minute thorns; the upper one somewhat longer; lengths to that of an arm joint, 4, 3, 2·8, 1·6, 1·6, 1·6 : 1·2. One small blunt, pointed tentacle scale. Colour in alcohol, disk above dull chocolate-brown, lower side and arms pale brown.

The only essential variation noted was in a larger specimen, with a disk of 18 mm., which had sometimes as few as seven mouth papillæ to an angle.

Station 298.—November 17, 1875; lat. 34° 7′ S., long. 73° 56′ W.; 2225 fathoms grey mud.

Ophiacantha stimulea, Lym. (Pl. XIII. figs. 4–6).

Ophiacantha stimulea, Lym., Bull. Mus. Comp. Zool., vol. v., part 7, p. 141, pl. ix. figs. 225–228, 1878.

Disk closely set with small simple spines. Arm spines not thorny. One or two large long tentacle scales.

(Type specimen from Station 164.) Diameter of disk 7 mm. Length of arm 35 mm. Width of arm without spines 2 mm. Ten or twelve pointed, flat, rather thin mouth papillæ, of which the two innermost are largest, the others about equal. Teeth similar to innermost mouth papillæ, but larger. Mouth shields wider than long, rather small, bounded without by a curve and within by an obtuse angle. Side mouth shields somewhat curved, rather narrow within, where they meet, wide without. Under arm plates wider without, where they are bounded by a gentle curve, than within, where they present an obtuse angle; lateral sides slightly re-enteringly curved. Upper arm plates fan-shaped, with an angle inward. Side arm plates stout and prominent, meeting narrowly above and below, near base of arm. Disk a little puffed, with a constriction in each interbrachial margin, closely set with small simple spines, which, under the microscope are seen to be slightly rough at their tips; just over each arm they are much shorter, and extend to the first upper arm plate. Radial shields and scaling wholly obscured by thick skin and spines, except on a small patch next mouth shields. Seven regular, not thorny, nearly cylindrical, rather slender arm spines, which taper slowly to a blunt point; lengths to that of an arm joint, 2, 3, 2, 1·5, 1·5, 1·5, 1 : ·8. Tentacle scales long, pointed, and rather wide; two on each of first two or three pores, and one on those beyond. Colour in alcohol, white.

Station 164.—June 12, 1874; lat. 34° 8′ S., long. 152, 0′ E.; 950 fathoms; grey ooze.

This species is distinguished from *Ophiacantha segesta* by more numerous and different mouth papillæ and by stouter arm spines.

Ophiacantha segesta, Lym. (Pl. XV. figs. 1, 2).

Ophiacantha segesta, Lym., Bull. Mus. Comp. Zool., vol. v., part 7, p. 141, pl. x. fig. 271, 1878.

Disk beset with short, smooth, slender spines, mingled with minute thorny stumps; arm spines not thorny.

(Type specimen from Station 56.) Diameter of disk 3·5 mm. Length of arm 15 mm. Width of arm without spines 1 mm. Seven regular, sharp, conical mouth papillæ to each angle, whereof the innermost is much the largest, and resembles the teeth, which are stout, blunt, spearhead-shaped. Mouth shields small, wider than long, with a point within and a curve without. Side mouth shields wide, thick, and somewhat curved. Under arm plates thick and swollen, pentagonal, with an angle inward and outer side widest. Upper arm plates thick and swollen, short fan-shaped, with an angle inward. Side arm plates large, meeting widely above and below, swelling gradually to form the spine ridges, which are not narrow or abrupt. Disk thickly set with small, slender, smooth spines, among which appear minute thorny stumps and crochets. Scaling and radial shields hidden, except outer tips of the latter. Seven smooth, tapering, cylindrical arm spines near base of arm, of which the two upper ones are much the longest, attaining a length of 1·7 mm.; the lower ones are short and stout. At tip of arm the lowest spine is slender, a little curved, and slightly rough on its edge. One small pointed tentacle scale. Colour in alcohol, white.

A young and immature specimen; but distinctly characterised by its spiny disk.

Station 56.—May 29, 1873; off Bermudas; 1075 fathoms; grey ooze.

Ophiacantha abnormis, Lym. (Pl. XXVI. figs. 4–6).

Ophiacantha abnormis, Lym., Bull. Mus. Comp. Zool., vol. vi., part 2, p. 59, pl. xv. figs. 411–413, 1879.

Mouth angles elongated, bearing, towards the apex, twelve or fourteen slender, pointed papillæ. Six long, smooth, slender arm spines. Disk sparsely set with very short spines.

(Type specimen from Station 207.) Diameter of disk 11 mm. Length of arm, which is very attenuated near its end, 73 mm. Width of arm close to disk, without spines, 2·5 mm. Mouth angles elongated, having no papillæ on their outer part near the mouth tentacles, but on their inner portion bearing four or five slender, spaced papillæ on each side, and a cluster of three or four at the apex. Teeth wide and large, with a broad cutting edge. Mouth shields broad triangular, with a small peak on the outer edge, and blunt angle within. Side mouth shields short and extremely narrow, just meeting within. Under arm plates thin and sunken, pentagonal, with a broad angle inward, outer edge straight, and deep re-entering curves on the lateral sides. Beyond the third, they are separated by the side arm plates, which meet below and above and have a high wide spine ridge. Upper arm plates triangular, somewhat swollen, with an angle inward,

sharp lateral corners, and broad nearly straight outer edge, which on the basal plates bears two minute spines. Disk flat, having re-entering curves in the interbrachial spaces, and rather sparsely set with minute, short, blunt spines, which are fewer below. The outer end of radial shields are exposed over the base of each arm. Genital openings long and large, extending from mouth shield to disk margin. Six long, slender, smooth, cylindrical tapering arm spines, of which the two upper ones are as long as two arm joints, thence diminishing in length to the lowest, which is about as long as half a joint. Pores large and tentacles very long; on basal ones are two scales, of a pointed oval shape; on those beyond, only one. Colour in alcohol, straw.

Station 207.—January 16, 1875; lat. 12° 21′ N., long. 122° 15′ E.; 700 fathoms; mud. Station 210.—January 25, 1875; lat. 9° 26′ N., long. 123, 45′ E.; 375 fathoms; mud.

In its elongated mouth angles, this species somewhat resembles *Ophiacantha hirsuta*, but its arm spines are smooth and in all ways different.

Ophiacantha troscheli, Lym. (Pl. XIII. figs. 1–3).

Ophiacantha troscheli, Lym., Bull. Mus. Comp. Zool., vol. v., part 7, p. 142, pl. ix. figs. 222-224, 1878; Bull. Mus. Comp. Zool., vol. v., part 9, p. 230.

Narrow ridge-like radial shields, which are partly naked. Disk beset on radial shields and centre with short, scarcely thorny spines, and in the interbrachial spaces with grains. Arms long and sinuous. Five or six stout, nearly smooth arm spines.

(Type specimen from Station 33.) Diameter of disk 7 mm. Length of arm 84 mm. Width of arm without spines 1·8 mm. Seven stout, short, blunt-pointed mouth papillæ to each angle, of which the innermost, standing under the teeth, is sometimes represented by two. Six or seven short blunt teeth. Mouth shields small, with an angle within and a curve without; length to breadth ·8 : 1·2. Side mouth shields wide, with curved sides, extending well beyond mouth shield on either side and meeting within. Under arm plates rather thick and somewhat obscured by skin; rudely pentagonal, with an obtuse angle inward; first plate longer than broad, irregular, compressed, six sided; second plate also longer than broad, curved without and wider than within. Upper arm plate rather thick, yet showing the median ridge of the underlying arm bone; four sided, outer side curved or wavy, and wider than inner one, lateral sides nearly straight; length to breadth, 1·2 : 1·2. Side arm plates not meeting above near base of arm, and barely touching below; projecting very slightly even near end of arm, so that the knotted or bead-like outline usual in the genus is not seen. Disk set with numerous, essentially smooth spines about 1 mm. long, which stand mostly in centre and on radial shields; interbrachial spaces sparsely granulated. Radial shields naked for a large part of their length, long, narrow, joined, raised above surrounding surface; scaling hidden. Five or six essentially smooth, tapering, and nearly equal arm

spines, of which, however, the upper one is much the stoutest; lengths to that of an arm-joint, 1·8, 1·6, 1·5, 1·5, 1·5 : 1·2, or 2·2, 1·6, 1·5, 1·3, 1·3, 1·3 : 1·2. Tentacle scales flat, pointed, and rather small. Colour in alcohol, pale brown.

The species stands near the typical *Ophiacantha setosa* in respect to form of disk and length of arm; but it differs from this and most others of the genus in having naked radial shields and side arm plates which do not project to give a knotted look to the arm.

Station 33.—April 4, 1873; off Bermudas; 435 fathoms; mud. Two specimens from the "Blake" expedition, dredged in 101 fathoms by A. Agassiz, showed no important variations. The disk-grains were larger and more numerous.

Ophiacantha cuspidata, Lym. (Pl. XV. figs. 9, 10; Pl. XLI. figs. 12–14).

Ophiacantha cuspidata, Lym., Bull. Mus. Comp. Zool., vol. v., part 7, p. 143, pl. x. figs. 248–250, 1878.

Disk beset with thorny stumps; eight rather long, stout, and feebly thorny arm spines; about eleven long slender mouth papillæ.

(Type specimen from Station 344.) Diameter of disk 9 mm. Length of arm 63 mm. Width of arm without spines 3 mm. Ten or sometimes eleven long, flat, rather slender and irregular mouth papillæ, of which the outer one has often a spatula shape. Teeth long, spearhead-shaped. Mouth shields small, long pentagonal, with a wide obtuse angle within; length to breadth, 1 : 1. Side mouth shields small, narrow and crowded, meeting within. Under arm plates wider without than within, where they touch the next plate; bounded without by a rounded angle or a somewhat deep curve, within by a more gentle curve, and on the lateral sides, opposite tentacle scales, by re-entering curves. The second plate is narrower within, and has a wavy outer edge. Upper arm-plates fan shaped, with an angle inwards; the lateral corners are sharp, and the lateral sides slightly re-enteringly curved. Side arm plates moderately prominent, meeting narrowly above, but not below at base of arm. Disk moderately thick, not puffed, closely set with stout little stumps, each bearing a crown of five or six minute thorns. Radial shields and disk scales hidden by skin and the thorny stumps, except that the position of each radial shield is usually marked by a shallow furrow. Eight stout, long, cylindrical arm spines, tapering to a blunt point and set with fine thorns; lengths to that of an arm joint, 3·6, 5, 3, 2, 2, 2, 1·8, 1·4 : 1. On first pore two tentacle scales; on the rest a single large pointed scale. Colour in alcohol, dark straw.

A young specimen with a disk of only 1·5 mm. had an arm of 10 mm. The disk armature consisted of little crochets with two or three prongs; the arm joints were of course more constricted, and the upper and under arm plates were widely separated; there were four or five arm spines, whereof the first or second was much the longest; to each

mouth angle seven papillæ, whereof the lateral were bead-like and had not yet become long and slender.

Station 344.—April 3, 1876; off Ascension Island; 430 fathoms; hard ground.

Ophiacantha longidens, Lym. (Pl. XXV. figs. 7–9).

Ophiacantha longidens, Lym., Bull. Mus. Comp. Zool., vol. v., part 7, p. 144, pl. x. fig. 274, 1878.

Disk closely set with slender stumps, each bearing a crown of three to five long delicate thorns; arm spines translucent and thorny; seven long slender mouth papillæ; tentacle scales spiniform.

(Type specimen from Station Cebu, Philippines.) Diameter of disk 4 mm. Width of arm without spines 1 mm. Seven mouth papillæ to each angle, of which the lateral are long, spine-like and blunt; and the innermost one is of a blunt spearhead form, like the four teeth above. Mouth shield small, wider than long, bounded by a curve without, and an angle within. Side mouth shields small, narrow, meeting within. First under arm plate small and rounded; second of an irregular transverse diamond shape, wider than long, having the lateral corners sharp, and a slight lobe without (fig. 7); those immediately beyond are similar, having a wide axe shape, with a clean curve without. Upper arm plates small, of a wide fan shape, with the angle inward, and lateral corners sharp. Side arm plates rather large, meeting above and below, with a well marked spine ridge. Disk round, slightly puffed, densely set with slender, minute stumps, each bearing a crown of three to five long slender thorns. Scaling and radial shields hidden, except the outer tips of the latter. Seven flattened, translucent, thorny, rather blunt arm spines; lengths to that of an arm-joint, 2, 2, 1·7, 1·7, 1, 1, ·8 : ·7. One spiniform tentacle scale. Colour in alcohol, above, mottled brown; below, white with brown markings on arms.

Cebu, Philippines; 95 to 100 fathoms.

Ophiacantha nodosa, Lym. (Pl. XX. figs. 1–4).

Ophiacantha nodosa, Lym., Bull. Mus. Comp. Zool., vol. v., part 7, p. 144, pl. x. figs. 258–261, 1878.

Six arms; seven long mouth papillæ to each angle; disk closely set with coarse, stout stumps, having thorny ends and sides.

(Type specimen from Station 3.) Diameter of disk 7 mm. Width of arm without spines 2·3 mm. Seven narrow mouth papillæ, the outer one longest. Teeth long and narrow, though stouter than mouth papillæ. Mouth shield small pentagonal, with a wide angle inward; length to breadth, ·7 : ·7. Side mouth shields long, narrow, and curved, meeting within and extending without much beyond the mouth shield. Under

arm plates pentagonal, with a strongly curved outer side, and lateral and inner lateral sides re-enteringly curved; length to breadth (third plate) ·8 : 1. Upper arm plates broad transverse diamond-shape, widely separated. Side arm plates stout and prominent, meeting freely above and below. Disk densely set with coarse stumps, which bear a crown of strong thorns and are also usually thorny on their sides. Radial shields and scaling hidden, except the outer tips of the former. Seven or eight slender, feebly thorny arm spines; the upper one longest (3 mm.), the three lowest about equal. Tentacle scales long, large, and pointed. Colour in alcohol, grey.

Station 3.—February 18, 1873; lat. 25° 45′ N., long. 20° 12′ W.; 1525 fathoms.

The only specimen was a disk with the bases of the arms and a few arm spines. The characters were, however, distinct.

Ophiacantha cornuta, Lym. (Pl. XV. figs. 3–5).

Ophiacantha cornuta, Lym., Bull. Mus. Comp. Zool., vol. v., part 7, p. 145, pl. x. fig. 266, 1878.

Disk scales distinct and rather large, closely beset with small stumps, having a slender trunk bearing a crown of six or eight minute thorns. Lowest arm spine thickened and curved.

(Type specimen from Station 171.) Diameter of disk 5·5 mm. Width of arm without spines 2 mm. Seven mouth papillæ to each angle, of which the three innermost are long, cylindrical, and pointed; the odd one at angle of jaw being largest. Mouth shields much wider than long, with a curve without and an obtuse angle within; length to breadth, ·6 : 1·2. Side mouth shields wide and stout, broadly joined within. Under arm plates much wider than long, slightly curved without, having a little peak within, and the very short lateral sides re-enteringly curved; length to breadth, ·6 : 1·2. Upper arm plates small, much wider than long, almost of a transverse diamond shape, and lower than the ridge of the side arm plates, which are large, meeting broadly above and below, and having an unusually narrow projecting spine ridge continuous over the top of the arm. Disk, including radial shields, covered by distinct imbricated scales, two or three in the length of a millimetre, closely beset and partly obscured by little stumps consisting of a slender trunk bearing a crown of six or eight minute thorns. Eight translucent arm spines, all sharp and strongly thorny, except the lowest, which is thickened, curved, and slightly rough. Towards end of arm this spine is more curved and proportionately larger, and stands below three very slender arm spines. Tentacle scale flat, stout, pointed. Colour in alcohol, white.

This specimen was plainly not fully grown, and was imperfect by loss of some arm-spines, &c., but the adult does not probably differ much, while the hooked lowest arm spine and character of disk mark it well as a species. A young individual (Fiji Islands),

with a disk of 3 mm. and arms 14 mm. long, presented no variations beyond those of age, except that the lowest arm spine was rather less curved; there were four spines beside this, the uppermost being sometimes as long as 1·7 mm.

Station 170.—July 14, 1874; off Kermadec Island, Fiji; lat. 29° 55′ S., long. 178° 14′ W.; 520 fathoms. Station 171.—July 15, 1874; lat. 28° 33′ S., long. 177° 50′ W.; 600 fathoms.

Ophiacantha cosmica, Lym. (Pl. XIII. figs. 13–15).

Ophiacantha cosmica, Lym., Bull. Mus. Comp. Zool., vol. v., part 7, p. 146, pl. x. figs. 251–254, 262–265, 269, 270, 1878.

Eight or more feebly thorny arm spines. Side arm plates only moderately prominent. Disk crotchets rather coarse.

(Type specimen from Station 157.) Diameter of disk 18 mm. Length of arm 100 mm. Width of arm without spines 4 mm. Seven mouth papillæ to each angle, whereof the innermost is broad and flat, like the teeth; the others are short, pointed, and very stout; outside these, and a little higher in mouth slit, is often a rounded scale of the second mouth tentacle. Besides these there are, on the mouth frames, from two to four small, peg-like papillæ. Mouth shields wide heart-shape, with angle inward; length to breadth, 2 : 3·5. Side mouth shields rather narrow, somewhat curved, meeting within, closely joined to surrounding parts. Under arm plates wide pentagonal, with outer side curved, and laterals a little re-enteringly curved. Upper arm plates wide fan shaped, with an angle inward, which in the basal plates is truncated. Side arm plates stout and moderately prominent; meeting below, near base of arm, but not above. Towards end of arm they meet above and below, and are more prominent, so as to give it a somewhat knotted look. Disk full, and rising considerably above the arms; densely and evenly set with small stumps, which, being freed of skin, are seen to be composed of five or six thorns, of different lengths, soldered side by side; these stumps appear also on the first two upper arm plates. Radial shields and disk scales hidden. Eight even, translucent, cylindrical arm spines, which taper to a blunt point and are under the microscope slightly rough but not thorny; lengths to that of an arm joint, 3·5, 3·5, 2·8, 2·5, 2·5, 2·2, 2, 2 : 1·5. Tentacle scales rather small, longer than broad, pointed. Colour in alcohol, straw.

The specimen just described is unusually large for this division of the genus, which leads one to think that the bulk of those now known are immature, and therefore to be treated with all the more caution. The young of *Ophiacantha* differs from the adult as follows:—(1) The arm spines are fewer, longer, and more slender and thorny; (2) the side arm plates are much larger and more projecting, giving a strongly knotted or beaded look to the arm; (3) the mouth papillæ are often less numerous and more slender; (4) the armature of the disk is more delicate, and the stumps or spines more thorny. Thus,

a younger specimen from the same station had a disk of 6 mm. in diameter and an arm 33 mm. long. There were seven slender arm spines, the upper ones much the largest, and bearing fine thorns on the lower part of the shaft; the arms were decidedly knotted, though not so much so as in some other species (*e.g.*, *Ophiacantha serrata*). The disk stumps had a short trunk which supported a crown of four or five thorns.

Another specimen (Station 122) was a little larger than the foregoing, and resembled it. There were eight scarcely thorny arm spines, the three uppermost much the longest, 3·3 mm. The disk was closely and evenly set with slender stumps, having a trunk surmounted by a crown of rather long thorns. Station 218 furnished specimens remarkable for the number of arm spines. With a disk of only 7 mm. and arms of 32 mm. there were eleven arm spines, the uppermost being 2·3 mm. long, the lowest 1 mm., and the rest intermediate; the disk stumps were as in Station 122, but stouter. The great number of arm spines in rather small individuals is a grave variation; but others from the same quarter of the globe (Station 191) were normal in this respect. A specimen off Tristan d'Acunha had a disk 7 mm. in diameter and the arm about 37 mm. long. The outermost mouth papilla on either side was wide, and the next two were longer than usual. The upper arm spine was 3 mm. long, and feebly thorny for its whole length.

Ophiacantha cosmica appears in the entire southern hemisphere, from the Brazil coast, by the lone Island of Tristan d'Acunha, the antaractic zone, off New Guinea, and between Juan Fernandez and the South American coast, where it lives in 2225 fathoms. Off Brazil it is found in only 350 fathoms. Its extreme variations are described above, and are not very great. *Ophiacantha millespina*, Vll., stands very near and needs more study to establish its place.

Station 122.—September 10, 1873; lat. 9° 5′ S. to 9° 10′ S. long. 34° 49′ W. to 34° 53′ W.; 350 fathoms; mud. Off Tristan d'Acunha; 1000 fathoms. Station 146.—December 29, 1873; lat. 46° 46′ S., long. 45° 31′ E.; 1375 fathoms; globigerina ooze. Station 147.—December 30, 1873; lat. 46° 16′ S., long. 48° 27′ E.; 1600 fathoms; globigerina ooze. Station 153.—February 14, 1874; lat. 65° 42′ S., long. 79° 49′ E.; 1675 fathoms; mud. Station 156.—February 26, 1874; lat. 62° 26′ S., long. 95° 44′ E.; 1975 fathoms; diatom ooze. Station 157.—March 3, 1874; lat. 53° 55′ S., long. 108° 35′ E.; 1950 fathoms; diatom ooze. Station 158.—March 7, 1874; lat. 50° 1′ S., long. 123° 4′ E.; 1800 fathoms; globigerina ooze. Station 191.—September 23, 1874; lat. 5° 41′ S., long. 134° 4′ E.; 800 fathoms; mud. Station 218.—March 1, 1875; lat. 2° 33′ S., long. 144° 4′ E.; 1070 fathoms; globigerina ooze. Station 298.—November 17, 1875; lat. 34° 7′ S., long. 73° 56′ W.; 2225 fathoms; grey mud. Station 299.—December 14, 1875; lat. 33° 31′ S., long. 74° 43′ W.; 2160 fathoms; grey mud.

Ophiacantha discoidea, Lym. (Pl. XXVI. figs. 1–3).

Ophiacantha discoidea, Bull. Mus. Comp. Zool., vol. vi., part 2, p. 57, pl. xv. figs. 405–407, 1879.

Seven or eight slender, translucent, nearly smooth arm spines. A small spine-like tentacle scale. Disk densely set with minute stumps crowned with thorns.

(Type specimen from Station 190.) Diameter of disk, 4·7 mm. Arms broken; they were plainly long, because, in their first 15 mm. there was scarcely any tapering. Width of arm near disk 1 mm. Three cylindrical, blunt, peg-like mouth papillæ on each side, and a similar but longer one at apex of mouth angle. Teeth longer than wide, with a rounded cutting edge. Mouth shields broader than long, regular heart-shaped, with point inwards; length to breadth, ·7 : 1. Side mouth shields very wide without, and overlapping the first under arm plate, but tapering to a thin point within, where they scarcely meet. First under arm plate longer than broad, and somewhat overlapped by side mouth shields; the plates just beyond are much wider than long, of a wide axe-shape, with a broad curve without, short re-entering curves on the sides, and an obtuse angle within. Side arm plates meeting above and below, stout and flaring, with a strong spine crest. Upper arm plates fan-shaped, with the angle inward; widely separated. Disk nearly round, a little puffed, closely and evenly set, except in the middle, with very short microscopic stumps crowned with three or four little thorns. No scales or radial shields appear in the alcoholic specimen. Seven or eight slender, pointed, translucent, nearly smooth arm spines, whereof the two uppermost are nearly as long as two joints; while those below gradually diminish in length to the lowest, which is two-thirds as long as a joint. One narrow, pointed tentacle scale. Colour in alcohol, pale brownish-grey.

Station 190.—September 12, 1874; lat. 8° 56′ S., long. 136° 5′ E.; 49 fathoms; mud.

This species stands nearest, perhaps, to *Ophiacantha cosmica* from which it is distinguished by different under arm plates, smaller side mouth shields, stouter disk stumps, and a very narrow spine-like tentacle scale.

Ophiacantha levispina, Lym. (Pl. XXV. figs 1–3).

Ophiacantha levispina, Lym., Bull, Mus. Comp. Zool., vol. v., part 7, p. 147, pl. x. fig. 277, 1878.

Disk closely beset with fine stumps bearing crowns of minute thorns; seven slender, not thorny arm spines; outer side of under arm plates strongly curved.

(Type specimen from Station 214.) Diameter of disk 6 mm. Length of arm 36 mm. Width of arm without spines 2 mm. Mouth papillæ seven to nine to each angle, whereof the outer one on either side is broad and scale-like, while the other five or seven are sharp and conical. Mouth shields broad heart shape, with the point inward; length to breadth,

1 : 1·3. Side mouth shields rather narrow, of nearly equal width, meeting within. Under arm plates wider than long, with a slight peak within, and the outer side (especially a little way out on arm) very strongly curved. Upper arm plates very small, sunken below the ridge of side arm plate, of a rounded fan shape, with an angle inward. Side arm plates large, meeting broadly above and below, with a spine ridge which swells gradually from the plate, and does not form a steep narrow crest. Disk densely beset with very fine, thorny stumps. Radial shields and scaling hidden. Seven long, slender, translucent arm spines, essentially smooth, only the lower ones being slightly rough under the microscope. Lengths to that of an arm joint, 3·5, 3·5, 3·5, 2·8, 1·8, 1·3, ·8 : ·8. Tentacle scales narrow and sharp. Colour in alcohol, white.

The great size of the side arm plates and the number and length of the arm spines mark this as an immature specimen, but the specific characters are not found in any other.

Station 214.—February 10, 1875; lat. 4° 33′ N., long 127° 6′ E.; 500 fathoms; globigerina ooze.

Ophiacantha serrata, Lym. (Pl. XV. figs. 6–8).

Ophiacantha serrata, Lym., Bull. Mus. Comp. Zool., vol. v., pt. 7, p. 148, pl. x. figs. 272, 273, 1878.

Disk closely and evenly set with minute grain-like stumps bearing a crown of blunt thorns; arm spines long, slender, strongly thorny, translucent, mounted on steep, narrow, much projecting side arm plates.

(Type specimen from Station 219.) Diameter of disk 6 mm. Length of arm about 32 mm. Width of arm without spines 1·8 mm. Seven flat, rather blunt mouth papillæ, not crowded; the innermost one much the largest and squarish; besides these, the first under arm plate bears two tentacle scales, one to each of second pair of mouth tentacles. Four flat teeth, similar in shape to the innermost mouth papillæ. Mouth shields much wider than long, of a transverse diamond shape, with lobe-like angles. Side mouth shields straight and narrow, nearly or quite meeting within. First under arm plate small and rounded, and bearing on its inner edge two tentacle scales; second plate long axe-shaped, with a curve without, a well marked angle within, and lateral sides re-enteringly curved; third plate proportionately shorter and with the inner side a very obtuse angle. Upper arm plates small, of a wide fan-shape, with the angle inward. Side arm plates large meeting widely above and below, rising very suddenly to form a high, narrow spine ridge, so that the arm has the look of a series of short cylinders alternating with burrs Disk densely and evenly beset with minute grain-like stumps, bearing a crown of blunt thorns. Scaling and radial shields covered, except outer tips of the latter. Nine long, slender, translucent, strongly thorny arm spines; lengths to that of an arm joint, 4, 4, 4, 3·2, 2·7, 2·5, 1·8, 1·8, 1·3 : 1. One small spiniform tentacle scale. Colour in alcohol, white mottled with pale brown.

The small number of teeth and large side arm plates show the specimen to be young, but the specific marks are good, and would be carried forward to the adult, which, doubtless, has ten or a dozen long, glassy, thorny, arm spines, with side arm plates not so exaggerated in their projection.

Station 219.—March 10, 1875; lat. 1° 50′ S., long. 146° 42′ E.; 150 fathoms; mud.

Species of *Ophiacantha* not herein described.

Ophiacantha sertata, Lym.

Ophiomitra sertata, Lym., Bull. Mus. Comp. Zool., vol. i., part 10, p. 326, 1869; Bull. Mus. Comp. Zool., vol. v., part 9, p. 231.

West Indies; 175 to 315 fathoms.

Ophiacantha spectabilis, G. O. Sars, Nye Echin. Vid. Selsk. Forh., 1871, p. 10.

Norway; 80 to 100 fathoms.

Ophiacantha millespina, Vll., Proc. U. S. National Museum, part 1, p. 203, November 1879.

Eastern slope of George's Bank; 220 fathoms.

Ophiacantha anomala, G. O. Sars, Nye Echin. Vid. Selsk. Forh., p. 12, 1871.

Norway; 200 fathoms.

Ophiacantha echinulata, Lym., Bull. Mus. Comp. Zool., vol. v., part 9, p. 229, pl. i. figs. 7–9, 1878.

West Indies; 995 fathoms.

Ophiacantha hirsuta, Lym., Ill. Cat. Mus. Comp. Zool., No. viii., part 2, p. 12, pl. ii. figs. 21–23, 1875; Bull. Mus. Comp. Zool., vol. v., part 9, p. 230.

West Indies; 127 to 175 fathoms; Barbadoes; 100 fathoms.

Ophiacantha smitti, Ljn., Dr. Goës, Oph. Öf Kong. Akad., p. 621, 1871.

Portugal; 790 fathoms.

Ophiacantha setosa, Müll. & Tr., Syst. Ast., p. 106, 1842; Ludwig, Echin. des Mittelmeeres, p. 548.

Asterias setosa, Retz., Diss., p. 30, 1805.
Ophiura rosularia, Grube (non Lmk.), Aktin. Echin. u. Wür., p. 20.
Ophiacantha scabra, Sars, Mid. Lit. Fauna, Nyt Mag. Natur., p. 78, pl. i. fig. 1, 1857.

Sicily, Mediterranean; 50 fathoms.

Ophiacantha aspera, Lym., Bull. Mus. Comp. Zool., vol. v., part 9, p. 228, pl. i. figs. 10–12, 1878.

Off Havana; 175 fathoms.

Ophiacantha indica, Ljn., Oph. Viv., Öf. Kong. Akad., p. 326, 1866.

Between Batavia and Singapore.

Ophiacantha dallasii, Duncan, Linn. Soc. Journ., vol. xiv. p. 471, pl. xi. figs. 25–27, 1879.

38° 19′ N. 129° 7′ E.; 50 fathoms.

Ophiacantha stellata, Lym., Ill. Cat. Mus Comp. Zool., No. viii., part 2, p. 11, pl. ii. figs. 16–18, 1875.

Barbadoes; 100 fathoms.

Ophiacantha scutata, Lym., Bull. Mus. Comp. Zool., vol. v., part 9, p. 229, pl. i. figs. 1–3, 1878.

West Indies; 287 to 292 fathoms.

Ophiacantha pentacrinus, Ltk., Addit. ad Hist., part 3, pp. 46 and 99, 1869; Lym., Bull. Mus. Comp. Zool., vol. v., part 9, p. 230.

Ophiacantha meridionalis, Lym., Bull. Mus. Comp. Zool., vol. i., part 10, p. 324, 1869.

West Indies; 74 to 539 fathoms.

Ophiacantha abyssicola, G. O. Sars, Nye Echin. Vid. Selsk. Forh., p. 8, 1871.

Lofoten Island; 20 to 300 fathoms.

Ophiacantha marsupialis, Lym., Ill. Cat. Mus. Comp. Zool., No. viii., part 2, p. 13, pl. i. figs. 9, 10, 1875.

Juan Fernandez; 240 fathoms.

Ophiolebes.

Ophiolebes, Lym., Bull. Mus. Comp. Zool., vol. v., part 7, 1878.

Disk and arms stout, and covered by a thick skin, which bears grains or stumps, and hides more or less the underlying plates. Arm spines short, blunt, thorny, covered by thick skin, and arranged on the sides of the side arm plates, which project but slightly. Long, stout mouth papillæ, and teeth; no tooth papillæ; peristomial plates large and wide, making a circle by their connecting ends. Arm plates rather small, but normal, nearly as in *Ophiacantha*. Two genital openings in each interbrachial space.

Dissection shows that Lütken was right, as against Ljungman and myself, in considering this genus (*Ophiactis clavigera*) nearer *Ophiacantha* than *Ophiactis*. Except in the lower interbrachial spaces, the skeleton and disk plates are more massive than in the former genus and the single peristomial plates are larger, so as even to form, in some cases, a closed ring round the mouth. The real generic distinction, however, is in the extremely thick external skin, and the comparatively ill-developed arm spines. So that its relation to *Ophiacantha* is about that of *Ophiolipus* to *Ophiomusium*.

See Plate XLI. fig. 8.

Ophiolebes scorteus, Lym. (Pl. XII. figs. 7–9; Pl. XLI. fig. 8).

Ophiolebes scorteus, Lym., Bull. Mus. Comp. Zool., vol. v., part 7, p. 158, pl. vii. figs. 196, 197, 1878.

Four short blunt arm spines covered with thick skin, the upper one longest. Five feeble mouth papillæ to each angle. Radial shields like ridges and set with grains.

(Type specimen from Station 145.) Diameter of disk 7·5 mm. Length of arm about 23 mm. Width of arm close to disk, without spines, 1·5 mm. There may be seen on each angle the outlines of five small mouth papillæ, two widely separated on the sides, and one longer and more slender at the apex, all covered by a thick skin, which, when removed, shows them as long, cylindrical, and stout. The mouth shields, whose outlines may be vaguely seen, are small triangular, with an angle inward and outer edge curved. Side mouth shields hidden by skin, which, when removed, shows them long and narrow, meeting within, and nearly or quite joining without, between first and second arm plates, so as to form a continuous line about the mouth. First under arm plate diamond-shape; the rest are pentagonal, with an angle inward and a notch without, but are hidden by thick skin. No side or upper arm plates visible, but on removing the skin, the latter are seen to be small, triangular, and separated by the side plates. Disk round and arched, covered by a thick skin which in the centre is irregularly wrinkled. Radial shields like long narrow ridges covered with a thick skin and set with small flat grains; the brachial and interbrachial spaces have the skin more or less wrinkled, and often with a few grains; the lower interbrachial spaces have the same thick, somewhat wrinkled skin. There are on the first three joints three arm spines; beyond this there are four: they are short, stout, and microscopically thorny, with blunt points, and are covered with thick skin; the upper spines being longest. No tentacle scales and apparently no tentacles beyond the basal joints. Colour in alcohol white.

Station 145.—December 27, 1873; lat. 46° 40′ S., long. 37° 50′ E.; 310 fathoms. Station 147.—December 30, 1873; lat. 46° 16′ S., long. 48° 27′ E.; 1600 fathoms; globigerina ooze.

Ophiolebes vestitus, Lym. (Pl. XII. figs. 10–12).

Ophiolebes vestitus, Lym., Bull. Mus. Comp. Zool., vol. v., part 7, p. 159, pl. x. figs. 255–257, 1878.

Disk covered by thick skin and set with short stumps, or grains, bearing a crown of blunt thorns. Arm spines short, stout, opaque, thorny. Mouth papillæ stout, blunt, spiniform.

(Type specimen from Station 308.) Diameter of disk 10 mm. Length of arm 50 mm. Width of arm without spines 2·3 mm. Nine mouth papillæ, of which the lateral are stout, blunt, cylindrical, crowded, somewhat movable, and with rough ends; the innermost is flat and squarish, like the teeth. Mouth shields small, wider than long, with a lobe without and an obtuse angle inward; length to breadth, 1 : 1·2. Side mouth shields somewhat curved, extending beyond mouth shield, wider without than within, where they meet. Under arm plates pentagonal, with a rounded angle inward. Upper arm plates fan shaped, with a truncated angle inward. Side arm plates meeting narrowly above and below, projecting but slightly. Disk a little puffed, covered by thick skin, and sparsely but regularly beset with short stumps or grains bearing a crown of blunt thorns. Six stout, cylindrical, blunt, thorny arm spines; lengths to that of an arm joint, 1·8, 1·2, 1, ·8, ·8, ·8 : ·8. One small, narrow, pointed tentacle scale. Colour in alcohol, white.

A young specimen with a disk of 4 mm. had arms 10 mm. long. The disk stumps were longer, and like very short thick spines. The arm spines were less thorny. In this stage it is very near the Ophiuran described by Ljungman as *Ophiactis clavigera*, which has the same habits also, and is doubtless the young of a form of *Ophiolebes*, like the present one. It differs in having the disk-scales and part of the radial shields naked.

That *Ophiolebes claviger* is of a novel type is shown by the fact that Ljungman considered it an extreme modification of *Ophiactis*, while Lütken deemed it nearer *Ophiacantha*.

Station 307.—January 4, 1876; lat. 49° 24′ S., long. 74° 23′ W.; 147 fathoms; mud. Station 308.—January 5, 1876; lat. 50° 10′ S., long 74° 42′ W.; 175 fathoms; mud. Station 310.—January 10, 1876; lat. 51° 30′ S., long. 74° 3′ W.; 400 fathoms; mud.

Species of *Ophiolebes* not herein described.

Ophiolebes claviger, Lym.

Ophiactis clavigera, Ljn., Tillägg Skan. Oph. Öf. Kong. Akad., p. 365, 1864; Oph. Viv. Öf. Kong. Akad., p. 325, 1866.

South Norway; 200 to 300 fathoms.

Ophiolebes humilis, Lym.

Ophiactis humilis, Lym., Bull. Mus. Comp. Zool., vol. i., part 10, p. 329, 1869.

Florida; 125 to 324 fathoms.

Ophiomitra.

Ophiomitra, Lym., Bull. Mus. Comp. Zool., vol. i., part 10, 1869.

Teeth. Numerous (7–11) small, nearly equal mouth papillæ. No tooth papillæ. Disk flat, circular, and erect, covered with scales and wide radial shields, and beset with thorny spines or stumps. Arm spines rough. Side arm plates large and nearly or quite meeting above and below, two genital openings in each interbrachial space.

So far as concerns the arms and the chewing apparatus, this is an *Ophiacantha;* but the disk, with its large naked scales and broad radial shields, separates it from that genus, which is characterised by the long, very narrow, radial shields, covered, together with the disk, by a thin skin bearing more or less thorny appendages.

In typical species (*Ophiomitra valida*) the arm spines are solid, like those of *Ophiocamax;* but others (*Ophiomitra chelys*) have them hollow, like *Ophiacantha.* The radial shields are always large and wide, sometimes flat (*Ophiomitra valida*) at others countersunk in a sort of fold (*Ophiomitra chelys*). The strong mouth angles have a thick, single, swollen peristomial plate (removed in Pl. XLI. fig. 4), which covers a very deep nerve ring (*u*). The genital plate is short and club-like, with a short, curved, blade-like scale. This scale in *Ophiomitra chelys* is short, straight, and rounded. The first free arm bone has a lozenge-shaped top, with a sunken centre (*w'*). On their outer face, the arm bones, which are much wider than long, have very prominent tentacle sockets (fig. 5*r*), while the inner face has flat wings and a prominent umbo (fig. 6).

See Plate XLI. figs 4–6.

Table of Species of *Ophiomitra.*

Nine rough, stout, solid arm spines. Disk evenly covered with large radial shields and scales, beset with thorny stumps,	*Ophiomitra valida.*
Six smooth, short, tapering arm spines. Upper disk bearing a few thorny stumps, and covered almost wholly by the large radial shields,	*Ophiomitra exigua.*
Four smooth, slender, solid arm spines. Disk sparsely granulated,	*Ophiomitra normani.*
Five to six stout arm spines. Outer edge of under arm plate swollen, and in large specimens turned down,	*Ophiomitra plicata.*
Eight arm spines, less stout than in preceding. Tentacle scales thorny,	*Ophiomitra sarsii.*
Six arm spines; under one thickened or bent. Radial shields widely separated,	*Ophiomitra chelys.*
Six arm spines; the under one straight. Tentacle scales thorny. Under arm spine straight,	*Ophiomitra carduus.*
Six arm spines, the two uppermost very long and slender. Marginal disk plates large and much swollen. Central disk scales small,	*Ophiomitra dipsacos.*

Ophiomitra plicata, Lym. (Pl. X. figs. 7–9).

Ophiomitra plicata, Lym., Bull. Mus. Comp. Zool., vol. v., part 7, p. 150, pl. viii. figs. 209–212; pl. ix. figs. 233–235, 1878.

Mouth papillæ thick, spiniform. Arm spines five or six, stout and cylindrical. Outer edge of under arm plates swollen and in large specimens turned down. Disk spines stout and conical.

(Type specimen from Station 205.) Diameter of disk 16 mm. Length of arm about 132 mm. Width of arm without spines 5 mm. Mouth papillæ nine to each mouth angle; stout, spiniform, about equal, blunt. Teeth similar to mouth papillæ, but shorter and flatter. Mouth shields small, as long as broad, with an irregular outline; the outer margin more or less thickened and curled downwards; length to breadth, 2 : 2. Side mouth shield broad, thick, and closely joined to the surrounding parts. Under arm plates broader than long, broader without than within, separated by transverse depressions; outer edge much thickened and curled downwards. Near end of arm they are wide pentagonal, with an angle inward and the outer edge scarcely thickened. Side arm plates slightly projecting near base of arm; meeting narrowly below, and scarcely or not at all above. Upper arm plates wider than long, irregular in shape, with a curved outer side and an obtuse or irregular angle inward; length to breadth about 1·5 : 3·5. Disk (in alcohol) thick, rising well above the arms, and with a deep constriction and furrow in each interbrachial space. Along the outer portion of the interbrachial edge of each radial shield lie three or four plates, broader than long, and running diagonally outward; the rest of the disk is occupied by coarse, irregular, overlapping scales, beset with short, stout, blunt, smooth, conical spines, which form an irregular line over the base of each arm. Radial shields sunken, and much longer than broad, narrowest within, rounded and swollen without; length to breadth, 5 : 2; separated by one or more narrow scales. Five stout, cylindrical, rather short arm spines, tapering to a blunt point, with thorns on all sides; lengths to that of an arm joint, 3·7, 4, 3·7, 3, 2·5 : 2. Two-thirds out on the arm, the second spine is much longer and attains a length of 8 mm. Tentacle scales very stout, and thickened at the base; pointed at the tip. On each of the first pair of pores there usually are three, on the rest only one. Towards tip of arm the scale becomes spiniform. Colour in alcohol, pale brown.

Station 205.—November 13, 1874; lat. 16° 42′ N., long. 119° 22′ E.; 1050 fathoms; grey ooze.

Smaller specimens (Station 214) presented considerable variations: with a disk of 10 mm. the arm was 60 mm. long; there were only seven mouth papillæ to each angle; the disk spines were thorny, the upper arm plates narrow; the outer edge of the under arm plates was somewhat swollen, but not curled down; the first tentacle pore had only one or two scales; there were six comparatively long arm spines, whose lengths to that of an arm joint were 5·2, 3, 2·8, 1·8, 1·8, 1·5 : 1·3. Other specimens (Station

170), with disks from 12 mm. to 9 mm. in diameter, had smooth disk spines, like Station 205, and six arm spines, and upper and under arm plates, like Station 214. The number of mouth papillæ to each angle varied from seven to ten, without reference to size of specimen.

Station 170.—July 14, 1874; lat. 29° 45′ S., long. 178° 11′ W.; 630 fathoms. Station 205.—1050 fathoms. Station 214.—February 10, 1875; lat. 4° 33′ N., long. 127° 6′ E.; 500 fathoms; globigerina ooze.

Ophiomitra sarsii, Lym. (Pl. X. figs. 10–12).

Ophiomitra sarsii, Lym., Bull. Mus. Comp. Zool., vol. vii. p. 151, pl. viii. figs. 216, 217, 1878.

Eight stout cylindrical arm spines. Tentacle scales flat, tapering, jagged. Scaling of disk finer than in *Ophiomitra plicata*.

(Type specimen from Station 146.) Diameter of disk 15 mm. Length of arm about 100 mm. Width of arm without spines 4·5 mm. Seven or eight thick-pointed mouth papillæ to each angle. Seven teeth of similar form, but more blunt and flat. Mouth shields small, as long as broad, with an irregular outline; outer margin more or less thickened and turned downward; length to breadth, 2 : 2. Side mouth shields broad and thick, and closely joined to surrounding parts. Under arm plates broader than long, broader without than within, separated by slight transverse depressions; outer edge thickened, especially at its middle point. Midway on the arm, they are wide pentagonal, with an obtuse angle inward, and the outer edge not thickened. Side arm plates slightly projecting, meeting near base of arm narrowly below and scarcely or not at all above. Upper arm plates separated by transverse creases, thick, wider than long; widest without, where they are bounded by a gentle curve; inner side making a deep irregular curve. Disk (in alcohol) thick, rising well above the arms, with a deep constriction and furrow in each interbrachial space. On margin of disk and along outer interbrachial edge of radial shields lie three or four wide plates larger than the rest, which are coarse, irregular, overlapping scales, beset with short, stout, smooth, often club-ended spines, which are found also on edge of disk over the arms. Radial shields pearseed-shaped, with point inward, sunken, outer end rounded, separated widely by a broad wedge of scales; length to breadth, 4 : 1·8. Near base of arm eight stout, glassy, blunt, cylindrical, very thorny spines, of which the under are nearly as long as the upper; lengths to that of an arm joint, 2, 3·8, 3, 2·8, 2·8, 2·8, 2·5, 2·5 : 1·7. Two-thirds out on the arm there are only four spines, of which the second is much the longest, 5·5 mm. Two tentacle scales on the first pore, one on the others; stout, pointed, flattened, cloven- or jagged on the edges; farther out they take on the form of stout, very thorny spines. Colour in alcohol, dull grey.

A smaller specimen with a disk of 10 mm. varied little, except that the upper arm plates were narrower and thinner, and the disk scales smaller and beset with few spines. This species differs from *Ophiomitra plicata* in the cloven or thorny tentacle scales, and in the greater number of arm spines.

Station 146.—December 29, 1873; lat. 46° 46′ S., long. 45° 31′ E.; 1375 fathoms; globigerina ooze.

Ophiomitra chelys, Lym., Bull. Mus. Comp. Zool., vol. v., part 7, p. 152, pl. ix. figs. 239–241, 1878; Bull. Mus. Comp. Zool., vol. v., part 9, p. 231.

Ophiacantha chelys, Wyv. Thom., Voyage of the "Challenger," Atlantic, vol. ii. p. 64, figs. 16, 17.

Radial shields widely separated; along their entire interbrachial margin run large disk plates. Under arm plates not swollen. Tentacle scales large and flat. Under arm spine thickened and curved.

(Type specimen from Station 84.) Diameter of disk 9 mm. Length of arm about 85 mm. Width of arm near base 2·8 mm. Mouth papillæ usually eleven to each angle, of which the central one within is wide and flat; the next three on either side are stout and pointed, and the outer ones are irregular, compressed, and sometimes broken. Teeth similar in shape to the odd innermost mouth papilla.[1] Mouth shields small, as long as broad, shield shaped, with a well-marked obtuse angle inward and outer margin sometimes turned down; length to breadth, 2 : 2·3. Side mouth shields broad and thick, a little widest at outer ends. Under arm plates large, thick, and regular, much wider than long, reaching at their outer edge entirely across the arm; cleanly curved without, re-enteringly curved on sides, and having a little peak within where separated from next plate. First plate small, narrow wedge shaped. Upper arm plates somewhat swollen, widely separated, wider than long, bounded without by a gentle curve, and within by an obtuse angle or a deep curve. Side arm plates prominent and meeting freely above and below. Disk thick and rising well above the arms, with a very deep, narrow constriction and furrow in each interbrachial space. The space between this furrow and the radial shields is on either side occupied by four large plates running diagonally inward, whereof one or more are often broken in two. The central disk is sunken, and covered by small, coarse, irregular scales, which, with the larger plates, are sparsely beset with short, blunt, usually smooth stumps or spines, which form also an irregular clump over each arm. Radial shields deeply sunken in a furrow, widely separated by a high ridge of irregular scales, much longer than broad, presenting an acute angle inward; length to breadth, 3 : ·8. Near base of arm six stout, very thorny, glassy, blunt, cylindrical arm spines, the lowest ones much the stoutest; lengths to that of an arm joint, 3·6, 3·6, 2·8, 1·7, 1·7, 1·7 : 1·2. Two-thirds out on the

[1] The nomenclature of the various papillæ of the mouth is of course conventional. In most cases the lowest tooth may also be called the innermost mouth papilla

arm the spines are more slender, and the second much longer, attaining to 5 mm. The under spine is marked by its thickness; beyond base of arm it is somewhat curved. Tentacle scales large, thick, pointed, flattened, sensibly smooth, except towards end of arm, where they bear two or three microscopic thorns. Colour in alcohol, dull straw.

It is not easy to say how much of the peculiar creasing of the disk and sinking of the radial shields is due to the contraction of the animal drawn from a depth and immersed in strong alcohol, and how much is natural. Of nine specimens one had radial shields much wider and more nearly on a level with the disk; but in the rest the radial shields were deeply sunken. Six specimens from the "Blake" expedition (Agassiz and Sigsbee, 1878) semed a variety of this species. They were from 480 to 860 fathoms, near Cuba. All had the radial shields not at all sunken and of a broad pearseed-shape; only the centre of the disk bore stumps, which were little articulated cylinders bearing a crown of thorns. The largest specimen, with a disk of 8 mm., had seven arm spines, which were stouter than in Challenger specimens and shorter, their lengths being 2, 3, 2·2, 2, 1·5, 1·5, 1·2; and the lowest spine, though thick, was scarcely or not at all curved. The other specimens were young, and had long slender arm spines, and the under one curved. The Challenger specimen from Station 33 resembled these.

Station 3.—February 18, 1873; lat. 25° 45′ N., long. 20° 12′ W.; 1525 fathoms; Station 33.—April 4, 1873; off Bermudas; (var. ?); 435 fathoms; mud. Station 84.—July 18, 1873; lat. 30° 38′ N., long. 18° 5′ W.; 1124 fathoms.

Ophiomitra carduus, Lym. (Pl. XIV. figs. 4–6).

Ophiomitra carduus, Lym., Bull. Mus. Comp. Zool., vol. v., part 7, p. 154, pl. ix. figs. 236–238, 1878.

Outer edges of under arm plates swollen. Tentacle scales strongly thorny. Under arm spine straight.

(Type specimen from Station 87.) Diameter of disk 10 mm. Width of arm without spines 2·8 mm. Mouth papillæ nine to eleven to each angle, of which the inner central one has a flat spearhead-shape; the others irregularly conical with blunt points; several of them much larger, and resembling the innermost one; others, especially the outermost, small, crowded, and ill-defined. Mouth shields small, broader than long, with an obtuse angle within and a truncated angle or a broken curve without, outer edge somewhat indented; length to breadth 1·7 : 2·2. Side mouth shields very broad and curved on their outer edge, almost crescent-like. Under arm plates near base of arm large, much wider than long, with a small swelling at their outer edge, which is gently curved and reaches nearly across the arm; lateral sides re-enteringly curved, with a peak within, where each plate is widely separated from its neighbour by the side arm plates. Upper arm plates somewhat swollen, bounded without by a gentle curve, and within by an obtuse angle or a deep curve. Side arm plates stout and prominent, meeting broadly

below, and, beyond the third plate, above also. Disk moderately thick, rising somewhat above the arms, with a deep constriction in each interbrachial space. The area between this constriction of the radial shields is occupied on either side by four or five transverse plates running diagonally inward, whereof one or more are often broken in two. Central disk somewhat sunken and covered with coarse, irregular, overlapping scales, which with the larger plates and edge of disk, are closely beset with little cylinders bearing a crown of thorns. Radial shields of an irregular pearseed-shape, with an angle inward, wavy, scarcely sunken, very wide, separated by a broad wedge of scales forming a median hump or ridge; length to breadth, 3·7 : 2. Near base of arm, six rather stout, thorny, glassy, blunt cylindrical arm spines, the lowest ones shortest and stoutest, but not curved; lengths to that of an arm joint, 3·3, 3·3, 2·1, 1·8, 1·8, 1·7 : 1·3. Beyond first pair of pores the tentacle scales are cloven, or have a long point, with one or more side thorns; towards middle of arm these thorns become stronger and the scale more pointed. Colour in alcohol, dull straw.

A smaller specimen, with a disk of 8 mm., had arms about 65 mm. long. The disk stumps were more thorny than in the larger one, and the tentacle scales, beyond middle of arm, were short spines, with several sharp, slender side thorns. It is to be noticed that the size and shape of the tentacle scale, when specimens of the same size are compared, give a pretty constant character in *Ophiacantha* and *Ophiomitra*.

Station 87.—July 21, 1873; lat. 25° 49′ N., long. 20° 12′ W.; 1675 fathoms.

Ophiomitra dipsacos, Lym. (Pl. X. figs. 4–6).

Ophiomitra dipsacos, Lym., Bull. Mus. Comp. Zool., vol. v., part 7, p. 155, pl. viii. figs. 213–215, 1878.

Upper arm spines long and slender, marginal disk plates large and swollen; central disk scales fine, and bearing minute thorny stumps; arm wide.

(Type specimen from Station 24.) Diameter of disk 10 mm. Width of arm without spines 3·4 mm. Mouth papillæ nine to eleven to each angle, whereof the innermost odd one is flat spearhead-shape; and the two outer ones on each side are ill-defined, being sometimes small papillæ, or again forming a sort of curled sheath to the mouth tentacle; the other papillæ are pointed and flattened. Mouth shields as long as broad, small, having an obtuse angle within, and a truncated angle or a deep curve without; outer edge often a little curled; length to breadth, 2 : 2. Side mouth shields wide, with outer side strongly curved. Under arm plates, near base of arm, large, much wider than long, with an outer edge gently curved and slightly thickened, and reaching nearly across the arm; lateral sides re-enteringly curved, with a peak within, where each plate is separated from its neighbour by the side arm plates. Upper arm plates slightly swollen, bounded without by a gentle curve, and within by a deep curve or truncated angle; they are separated by side arm plates, which are prominent, and meet freely

above and below. Disk thick and puffed, rising well above the arms, with a constriction and furrow in each interbrachial space. The area between this constriction and the radial shields, on either side, is occupied by four transverse plates running diagonally inward, and outside these is a similar larger plate forming the margin of the disk. Central disk covered with fine overlapping scales, eight or ten on a line between central point and inner angle of radial shield; they are sparsely beset with minute stumps bearing a crown of thorns. On the disk margin, over each arm, a few small grains or stumps. Radial shields of a wide pearseed-shape, with an angle inward, nearly or quite joined without; separated within by a broad wedge of scales; length to breadth, 2·8 : 1·7. Near base of arm six strongly thorny, glassy, cylindrical, hollow arm spines, whereof the two upper ones are very long, slender, and tapering, and the lowest is thick and blunt; lengths to that of an arm joint, 5, 7, 3·5, 2·5, 2, 1·8 : 1·3. Two large pointed tentacle scales on the first pore; one on each of those beyond; toward middle of arm the scales are more elongated and pointed, and have one or two microscopic thorns. Colour in alcohol, very pale brown.

Station 24.—March 25, 1873; off Culebra, West Indies; 390 fathoms; mud.

Ophiomitra normani, Lym. (Pl. XXVI. figs. 9–11).

Ophiacantha normani, Lym., Bull. Mus. Comp. Zool., vol. vi., part 2, p. 58, pl. xv. figs. 414–416, 1879.

Disk distinctly scaled and sparsely granulated, and with small, separated radial shields. A single row of grains along the outer edge of the basal upper arm plates. Four smooth, slender spines, the upper ones longest.

(Type specimen from Station 232.) Diameter of disk 12·5 mm. Length of arm about 40 mm. Width of arm next disk 2·5 mm. Seven widely spaced, cylindrical, tapering, peg-like mouth papillæ, three on each side, and one at apex of mouth angle. Mouth shields a little broader than long, thick and square, with a little peak without and within; length to breadth, 1 : 2. Side mouth shields long and narrow, their outer end wedged between the first and second under arm plates; not quite meeting within. First under arm plate well marked, of a rounded triangular shape, with the point outward; third plate, and those just beyond it, broader than long, bounded without by a curve, on the sides by re-entering curves, and within by an angle; length to breadth (fourth plate), 1·3 : 1·7. Side arm plates with a swollen spine ridge, meeting below, but separated above; stout, and like the under plates, microscopically tuberculous. Upper arm plates about as broad as long, short wedge shaped, with outer side curved and a blunt angle within; the first three or four have, along their outer margin, a single row of rounded grains. Disk flat, somewhat angular, covered with well marked, pretty equal, overlapping scales, whose surface is sparsely set with rounded grains, similar to those of the upper arm plates; interbrachial spaces below similarly covered, except that

the scales are smaller and obscured by skin. Radial shields small, ovoid, as long as broad, widely separated by a wedge of scales; length to breadth, 1·7 : 1·3. Genital openings wide, and extending quite from the mouth shield to the disk margin. Four smooth, cylindrical, rather slender, blunt, tapering arm spines, whereof the lowest is as long as an arm joint, the two upper ones as long as a joint and a half, and the third intermediate. One rather large oval tentacle scale. Colour in alcohol, grey, with arm inclining to straw.

Station 232.—May 12, 1875; lat. 35° 11′ N., long. 139° 28′ E.; 345 fathoms; sandy mud. Station 235.—June 4, 1875; lat. 34° 7′ N., long. 138° 0′ E.; 565 fathoms; mud. Station 236.—June 5, 1875; lat. 34° 58′ N., long. 139° 30′ E.; young; 420 to 775 fathoms; mud.

Species of *Ophiomitra* not herein described.

Ophiomitra valida, Lym. (Pl. XLI. figs. 4–6).

Ophiomitra valida, Lym., Bull. Mus. Comp. Zool., vol. i., part 10, p. 325, 1869; Ill. Cat. Mus. Comp. Zool., No. vi., pl. ii. figs. 4–6.

Ophiomitra cervicornis (young form), Lym., Ill. Cat. Mus. Comp. Zool., No. viii., part 2, p. 14, pl. ii. figs. 19, 20, 1875; Bull. Mus. Comp. Zool., vol. v., part 9, p. 231.

West Indies; 10 to 128 fathoms.

Ophiomitra exigua, Lym., Bull. Mus. Comp. Zool., vol. v., part 9, p. 231, pl. i. figs. 4–6, 1878.

Off Havana; 240 fathoms.

Ophiocamax.

Ophiocamax, Lym., Bull. Mus. Comp. Zool., vol. v., part 7, 1878.

Seen from within the radial shields are even larger than they appear from without. Near their outer point of junction are attached genital plates which are peculiar in that their inner ends lie on top of the arm and nearly touch each other, while their very thin, blade-like shafts slope downwards and inwards to the sides of the arms. Also attached to the radial shield are the curved, thin genital scales (Pl. XLI. fig. 9, *n*). The arm next the mouth frames is very large and wide, and its bones are strong, with wide, slightly grooved margins. Their faces are of a character wholly unlooked for, recalling the remote *Astrophyton* shapes. Thus, the outer face has no articulating peg at all and the articulating hollow above (fig. 10 : 4) is formed by a transverse hour-glass piece, the whole quite comparable to such a remote genus as *Sigsbeia* (Pl. XLIII. fig. 5). The inner face is of a character much more Ophiuroid (Pl. XLI. fig. 11), and is comparable to that

of *Ophiochondrus* (Pl. XLIII. fig. 13), whose arm bones are, however, utterly different in other respects. Scarcely less curious are the mouth angles which are covered above by a large, swollen, spongy peristomial plate, and this is continued down the outer open angle by a film or veil of lime crust. Over the madreporic mouth shield this veil takes on the form of a sort of rude pillar of spongy lime scales, or spiculæ. The closing of the open angle of the mouth frame wings by a sort of crust is found elsewhere, but not in so complete a form. The jaws and jaw plate are swollen and powerful, and the teeth thick and cylindrical. The arm spines are solid with a peculiar wedge formation in cross section; and have a single row of thorns on each edge.

This is a genus like an elaborated *Ophiacantha* and which, by its great radial shields and its arm spines leans towards *Ophiothrix*, and yet one face of its arm bones has an *Astrophyton* structure! Here is one warning, among many, not to seek in Nature for a regular, progressive and consecutive development. To suppose that this arm bone was a last remnant of an *Astrophyton* progenitor, or the first hint of a future *Astrophyton*, would be to drag the camel through the postern. (See Pl. XLI. figs. 9–11.)

Some of the species, at any rate, are viviparous. A new one, dredged in an expedition of the U.S. Steamer "Blake," had a large bursa (Pl. XLVI. fig. 4, *Bu*), in whose wall were imbedded lime scales. Between this and the disk roof was a pocket (ovarial tube?) containing an embryo (♂), which was too macerated by alcohol to show much structure. The wall of the bursa was joined with that of the digestive cavity (*St*).

A section of the entire disk is given in Plate XLVII. fig. 5, showing the way in which the ovarial bursæ throw a fold over the digestive cavity.

Ophiocamax vitrea, Lym. (Pl. XIV. figs. 10–12).

Ophiocamax vitrea, Lym., Bull. Mus. Comp. Zool., vol. v., part 7, p. 156, pl. viii. figs. 218–221, pl. ix. figs. 242–244, 1878 (young).

Mouth papillæ numerous, spine-like, arranged in a tuft. Tentacle scales blunt spiniform, two or three to each pore. Disk covered above with rounded, equal, thin scales set thickly with minute thorns and crochets.

(Type specimen from Station 219.) Diameter of disk 17 mm. Width of arm without spines 4·4 mm. About thirty, long, spiniform, equal papillæ to each angle, set in two or three ranks; of which half a dozen are arranged under the teeth, and may be considered tooth papillæ; and three on either side are borne on a small plate or scale, at outer corner of mouth-slit, and cover the second mouth tentacle. Seven broad flat teeth, with a rounded cutting edge. Mouth shields small, broader than long, with an obtuse angle within and a truncated angle without, bearing a few short spines; length to breadth, 1·5 : 2. Side mouth shields exceptionally large and wide, meeting broadly within, having their inner sides gently curved. Under arm plates with a wide, slightly curved, somewhat swollen outer edge, and a narrow projection within, where they join

the next plates; on each lateral side a sharp re-entering curve, where the tentacle issues; length to breadth, 2 : 2·6. Side arm plates near base of arm not meeting below and scarcely above; forming broad, abrupt, but not very high ridges. Upper arm plates slightly swollen, about as broad as long, with a gentle curve without, and a deep curve within. The whole arm is sparsely set with minute points. Disk flat and even, closely set with fine short spines which are sharp and thorny or forked. Radial shields flat and regular, triangular, with an angle inward, bearing a few spines like those of the disk, and separated by a row of the same; length to breadth, 4 : 2·5. Near base of arm nine slender, slightly flattened, glassy arm spines, whereof the three lowest are very small. Unlike those of *Ophiacantha*, these spines are not hollow. Lengths to that of an arm joint, 3, 3, 3·6, 4, 3, 1·6, 1·2, ·8, ·6 : 2. Three stout, club-shaped, spiniform tentacle scales on the first pore, and usually two on those immediately beyond. Colour in alcohol, straw.

A younger specimen (Station 192), with a disk of 12 mm., had the upper arm plates longer; the basal under arm plates did not touch each other; the scaling of the disk was distinctly marked; there were three tentacle scales on the basal pores; the arm spines were seven; lengths to that of an arm joint, 2·2, 4·4, 3, 2·2, 2, 1·5, 1·2 : 1·5. The upper arm spine is sometimes the longest.

Station 192.—September 26, 1874; lat. 5° 42′ S., long. 132° 25′ E.; 129 fathoms; mud. Station 201.—October 26, 1874; lat. 7° 3′ N., long. 121° 48′ E.; 102 fathoms; stones and gravel. Station 204.—November 2, 1874; lat. 12° 43′ N., long. 122° 10′ E.; 100 fathoms; mud. Station 209.—January 22, 1875; lat. 10° 10′ N., long. 123° 55′ E.; 95 to 100 fathoms; mud. Station 219.—March 10, 1875; lat. 1° 50′ S., long. 146° 42′ E.; 150 fathoms; mud.

Species of *Ophiocamax* not herein described.

Ophiocamax hystrix, Lym. (Pl. XLI. figs. 9–11).

Ophiocamax hystrix, Lym., Bull. Mus. Comp. Zool., vol. v., part 9, p. 232, pl. i. figs. 13–15, 1878.

West Indies; 175 fathoms.

Ophiothamnus.

Ophiothamnus, Lym., Bull. Mus. Comp. Zool., vol. i. part 10, 1869.

Disk beset with fine thorns or spines, and covered by rather large scales and wide naked radial shields. Teeth, and stout, close-set mouth papillæ, but no tooth papillæ. Numerous (eight) thorny translucent arm spines, arranged along sides of side arm plates, which are prominent, and nearly or quite meet above and below. In each interbrachial

space two genital openings, beginning close outside the mouth shield. The peristomial plate is in three pieces, arranged symmetrically like the mouth shield and side mouth shields.

Although strongly resembling *Ophiacantha* and *Ophiomitra* in outward aspect, this genus has a peculiar internal structure. In the first place there is no genital scale, and the genital plates, instead of occupying their usual position at the side of the arm, lie on top, side by side and touching each other. They are long, bar-like, and a little curved, and narrowest at their outer end (Pl. XLII. fig. 1, *o*). Then the ovarial bursæ have their walls clad in thin lime plates, making a regular wall in which I was unable to discover a genital opening of any sort (δ). The peristomial plates are of great size, completely covering each mouth angle, except its inner apex. They are in three pieces, two forming an angle, whose opening is closed by the third; the three resembling a mouth shield with its two side shields (*v,v*). The radial shields are large and wide, and touch each other for nearly their whole length.

See Plate XLII. fig. 1.

Ophiothamnus vicarius, Lym. (Pl. XLII. fig. 1).

Ophiothamnus vicarius, Lym., Bull. Mus. Comp. Zool., vol. i., part 10, p. 342, 1869; Ill. Cat. Mus. Comp. Zool., No. vi., pl. ii. figs. 8, 9, 1871; Bull. Mus. Comp. Zool., vol. v., part 7, p. 150; Bull. Mus. Comp. Zool., vol. v., part 9, p. 232.

Station 23.—March 15, 1873; off Sombrero Island; 450 fathoms; globigerina ooze.

Ophiothamnus remotus, Lym. (Pl. XIV. figs. 1–3).

Ophiothamnus remotus, Lym., Bull. Mus. Comp. Zool., vol. v., part 7, p. 149, pl. viii. figs. 201–203, 1878.

Disk scales coarse and angular. Side mouth shield very large, and meeting broadly within. Very few short spines on disk.

(Type specimen from Station 142.) Diameter of disk 3·3 mm. Length of arm 11 mm. Width of arm without spines 8 mm. Seven flat close-set mouth papillæ; the odd one, at the apex, being short spearhead-shaped, the rest squarish. Mouth shields small, three-sided, with a point inward, and the outer corners rounded; length to breadth ·4 : ·3. Side mouth shields very wide and large, meeting broadly within, and enveloping the mouth shield on all sides but one. First under arm plate small and wedge-shaped, with inner end rounded; the rest are pentagonal, with an obtuse angle inward, and outer corners somewhat rounded; the second plate is larger than those beyond. Side arm plates meeting broadly above and below, constricted within, swelling outward into a thickened spine ridge. Upper arm plates wider than long, irregular oval, with a slight peak within. Disk rather thick, covered above with coarse angular scales, whereof there are but two radiating rows in each interbrachial space; radial shields wide pearseed-

shape, with a rounded angle inward, joined their whole length, except their inner ends, which are separated by a wedge scale; interbrachial spaces below with a marginal constriction, and usually covered by four large rounded scales; there are a few short smooth disk spines. Seven slender, translucent, sharp, not thorny arm spines; lengths to that of an arm joint, 1·3, 1·3, 1, 1, ·6, ·4, ·4 : ·5. Beyond the basal joints there are but six spines, whereof the upper are shorter than those described above. One very small, narrow, pointed tentacle scale. Colour in alcohol, nearly white.

Ophiothamnus vicarius bears a general resemblance to this species, but is distinguished by narrower side mouth shields and by long and numerous disk spines.

Station 142, Agulhas Bank.—December 18, 1873; lat. 35° 4′ S., long. 18° 37′ E.; 150 fathoms; sand.

Species of *Ophiothamnus* not herein described.

Ophiothamnus affinis, Ljn., Dr. Goës, Oph. Öf. Kong. Akad., p. 622, 1871. Portugal; 790 fathoms.

Ophiothrix.

Ophiothrix, Müll. & Tr., Weig. Archiv, vol. vi., 1840.

Disk set with thorny grains, very short, spines crowned with thorns, or spines with thorns at the sides and top. Radial shields like large, triangular swellings, each bounded on its two inner sides by ridges in the skin of the back. Numerous crowded tooth papillæ forming a vertical oval. Teeth. No mouth papillæ. Spines numerous (five to ten) (often three times as long as the joints), flattened, more or less glassy, thorny, having a central shaft with slender side-spurs from it. A small, spine-like tentacle scale. The base of the jaw pierced with a hole, from a want of perfect union between the two pieces of the mouth frames. Interbrachial spaces swelled out like lobes. Two genital openings beginning outside the mouth shields. Outer arm joints with hooks.

We have here a type separated by a gap from genera previously described. Contrasted with the rather loose and feeble scaling are the very large, three-sided radial shields with projecting knobs at their outer ends, where they are articulated with the clubbed, knobby heads of the long, stout, rounded, and slightly curved genital plates (Pl. XLII. fig. 5, *o*). To this last is attached a great, almost semicircular genital scale (*n*), which is continued to the mouth shield (*a*) by an additional scale. The heads of the genital plates nearly meet over the top of the arm, which is composed of peculiar arm bones. Beginning at the third free bone, each has an upper forward projection or apophysis fitting into a slot in the upper hinder end of the next bone. Thus the joints are interlocked in a way that may give a fulcrum for the powerful muscular action called for in the rapid whip-like motion of the arm of *Ophiothrix*. By this peculiar locking contrivance, the

outer and inner faces of the arm bones are quite changed (figs. 6 and 7). The upper portion is occupied by the narrow apophysis, or, in the inner face, by the deep slot, so that the articulating umbo (1) and its corresponding hollow (4) are reduced to small proportions. The lower muscle-field (*w*) is also small as compared with the upper (*w'*). Not less characteristic are the mouth angles with their long-crested, deeply-grooved upper surface (*f*) nearly or quite destitute of a peristomial plate, the nerve being well protected by its extremely deep canal (*u*). The jaws (*c*) are very high, but not long. Their height (fig. 8) gives room for the great vertical oval of tooth papillæ (*d'*) and the numerous but shorter teeth (*d''*). In shape the jaw plate is like a shoe hole perforated for the attaching ligaments; the wider end is uppermost and bears the tooth papillæ. Outside this appears the jaw, at whose upper end is attached, as usual, a fold of the stomach (*st*), and in whose sides are the sockets from which issue the large fleshy mouth tentacles (*rr*).

Ophiothrix is the Salmo of echinoderms! Well defined and peculiar as a genus it has a crowd of species, many of which are the despair of the specific zoologist. From the internal skeleton some aid may be got in this direction. Thus *Ophiothrix hirsuta* has a thick disk skin set with small separated scales, each bearing a thorn, or spine. Its young has radial shields proportionately larger and more nearly approaching in the interbrachial spaces. From it the kindred species *Ophiothrix longipeda* is well distinguished by a generally lighter structure; a narrower genital scale, and more slender genital plate; smaller radial shields having over twenty interbrachial radiating scale rows, instead of eight to fourteen as in *Ophiothrix hirsuta;* and, finally, in having the outer horns of the mouth frames shorter and less grooved. *Ophiothrix trilineata* stands near, but has the disk scales large and few. *Ophiothrix augulata* and *Ophiothrix örstedii* have a similar general structure; but have a close, well-marked imbricated scaling, with about seven radiating interbrachial rows between the radial shields. Their young have proportionately smaller radial shields and the scales wider. *Ophiothrix spiculata* is closely allied, with larger radial shields, however, and the outer horns of the mouth frames much prolonged. *Ophiothrix fragilis, O. echinata, O. pentaphyllum, O. quinquemaculata,* and *O. alopecurus* have a common type. The first free arm-bone has a little hollow lozenge on its upper surface (fig. 5), while in most of the species it has a thin, slightly grooved margin. Then the narrow brachial space between the radial shields is filled by a line of long, thick scales. Finally, there is a large space of wholly naked skin near the mouth shields. The specific differences which I pointed out[1] between the large *Ophiothrix fragilis* of North Europe and the small *Ophiothrix echinata* of the Mediterranean are confirmed. A young of *Ophiothrix fragilis,* had a disk 6 mm. in diameter, whose upper surface was almost wholly filled by contiguous radial shields, while in *Ophiothrix echinata* (disk 8 mm.) there were as many as eight scale rows in each interbrachial space, and the radial shields had the lobed margin of the adult.

[1] Bull. Mus. Comp. Zool., vol. iii., part 10, p. 245.

Ophiothrix magnifica stands near, having a long genital plate reaching nearly to the mouth shield, and a hollow lozenge on top the first free arm bone; the genital scale too is extremely large and thick, and has a slightly lobed edge. The radial shields, however, are smaller than usual, with crusty, rounded, not elongated, scales in the interbrachial spaces.

Ophiothrix suensonii, which leads a distinct group of *Ophiothrices*, presents some variations in the skeleton. The radial shields are of great size, massive, and with smooth edges, and the pairs are scarcely separated. The first free arm bone has a slight elongation on its upper surface. The genital plate is flat and much thinner than in species already treated. The upward forward apophysis of the arm bones is even longer than usual, and of a somewhat different form.

See Plate XLII. figs. 5–8.

Table of Species of *Ophiothrix*.

Short narrow arms, four to six times diameter of disk. A notch or re-entering curve in outer side of under arm plates, eight to nine stout, blunt feebly thorny arm spines. Disk beset with stumps or spines. Radial shields essentially naked. On upper side of first undivided arm bone is a lozenge with a central depression.

Large (disk 16 mm.). Radial shields somewhat sunk in swollen disk, which bears various short stout stumps, mingled sometimes with a few slender long spines, . .	*Ophiothrix fragilis.*
Small (disk 11 mm.). Radial shields somewhat sunk in puffed disk, which is evenly beset with trifid stumps, mingled with a few cylindrical spines, . . .	*Ophiothrix echinata.*
Similar to *Ophiothrix echinata*, but lowest arm spine as far inward as seventh joint is a double or triple hook, .	*Ophiothrix roseocœrulans.*
Large and similar to *Ophiothrix fragilis*, but with short thin arm spines, high arched arms, and minute spines on upper arm plates, ...	*Ophiothrix lütkeni.*
Similar to *Ophiothrix fragilis* (same?). Disk beset with thorny grains, conical stumps, and very stout, columnar spines, ...	*Ophiothrix pentaphyllum.*
Disk above closely set with grassy fluted spines, without stumps. Radial shields naked, except sometimes a few minute spines, ...	*Ophiothrix alopecurus.*
Similar to *Ophiothrix echinata* (same?), but larger and disk beset with stouter stumps, and spines having crowns of three to seven thorns, ...	*Ophiothrix lusitanica.*
Similar to *Ophiothrix pentaphyllum* (same?), but only seven arm spines, and with a red spot on each upper arm plate, .	*Ophiothrix maculata.*
Arms seven to ten times diameter of disk. A few long disk spines which are jointed on little mamelons.	*Ophiothrix quinquemaculata.*
Second and third arm spines largest and slightly club-ended. Disk set with short thorny cylinders. Radial shields naked. Under arm plates transverse oblong with rounded corners, ...	*Ophiothrix fumaria.*

Table of Species of *Ophiothrix*—continued.

Arms five to six times diameter of disk. Radial shields essentially naked. A slight re-entering curve in outer side of under arm plate.	Disk beset with minute trifid stumps, among which a few slender spines. Colour in alcohol, blue, or pale pink, with a light line along upper arm,	*Ophiothrix angulata.*
	Disk beset with slender spines. Colour in alcohol, blue or green, with fine white cross-lines on arms,	*Ophiothrix örstedii.*
	Disk beset with thorny stumps and slender spines, or with either alone. Arm spines longer than in *Ophiothrix angulata*. Colour in alcohol, pale blue,	*Ophiothrix spiculata.*
	A few slender spines on disk. Several thin lines alternately blue and white, running along upper arm,	*Ophiothrix trilineata.*
	Similar to *Ophiothrix spiculata*, but under arm plates proportionately longer; and the lowest arm spine keeps the form of a double hook till quite near the base of the arm,	*Ophiothrix koreana.*
	Disk beset with coarse spines of several sizes. Arm spines stouter than in *Ophiothrix spiculata*, and under arm plates more angular,	*Ophiothrix dumosa.*
	Large (disk 14 mm.). Arm spines rounded, stout, and tapering. Disk closely set with similar smaller spines,	*Ophiothrix magnifica.*
	Disk with a few peg-like stumps. Upper arm plates hexagonal. Arm spines very stout. Colour in alcohol reddish, with black line along upper arm,	*Ophiothrix lineata.*
	Radial shields small and set, like disk, with small thorny stumps. Under arm plates with a re-entering curve on outer side. Arm spines thick and not strongly thorned,	*Ophiothrix triglochis.*
	Disk as in *Ophiothrix triglochis*, but arm spines much flatter and more toothed; and under arm plates are curved outwardly,	*Ophiothrix cæspitosa.*
	Radial shields naked. Upper disk set with minute, smooth, cylinders. Seven nearly cylindrical, tapering arm spines, only a little thorny at the tip. Under arm plates covered without,	*Ophiothrix rudis.*
	Radial shields and lower interbrachial spaces nearly naked; rest of disk densely set with stumps bearing a crown of thorns. Outer side of under arm plates curved. Seven short, flat, strongly toothed arm spines,	*Ophiothrix berberis.*
Some of the arm spines clubbed or widened at the end. Radial shields naked.	Radial shields naked. Upper arm spines club-ended. Arm to disk 7:1. Short spines on disk, which is spotted with black, and arms banded with same,	*Ophiothrix spongicola.*
	Radial shields naked. A few spines on disk. Arm spines with shaft smooth and a flat thorny end. Lower arm plates as broad as long and curved without,	*Ophiothrix melanosticta.*
	Disk as in preceding. Arm spines with smooth shaft and rough end; the second with a broadened flat, toothed end. Under arm plates squarish with an outer re-entering curve,	*Ophiothrix striolata.*
	Disk naked above, spinous below. Upper arm spines with smooth cylindric shaft and thorny clubbed end. Lowest one a trifle hooked. Arm to disk $4\frac{1}{2}$:1,	*Ophiothrix martensi.*
	Disk as in *Ophiothrix martensi*. Outer side of under arm plate re-enteringly curved. Most arm spines with brush like thorny ends. Arms to disk 5:1,	*Ophiothrix plana.*

Table of Species of *Ophiothrix*—continued.

Both disk and radial shields closely beset with thorny stumps, or short spines.	Radial shields naked. Arms long and flat; as compared with disk, 9–20 : 1.	Arm to disk 9 ; 1. Radial shields small. Disk beset with minute thorny stumps. Under arm plates much wider than long, with rounded corners,	*Ophiothrix aspidota.*
		Arm to disk 9 : 1. Outer edge of upper arm plates in three lobes. Upper disk naked, with numerous interbrachial radiating rows of scales,	*Ophiothrix triloba.*
		Arms to disk 9 : 1. Upper disk with a few rough grains. Only a few (five to seven) radiating scale rows in each interbrachial space,	*Ophiothrix propinqua.*
		Arm to disk 15 : 1. Upper disk with a few rough grains. In each interbrachial space only three or four large scales,	*Ophiothrix nereidina.*
		Arm to disk 15–20 : 1. Large species. Upper disk densely set with thorny grains or stumps. Interbrachial scaling obscured,	*Ophiothrix galateæ.*
		Arm to disk 12 : 1. Disk above and below beset with tapering thorny spines, of which few or none on radial shields,	*Ophiothrix virgata.*
		Arm to disk 15 : 1. Only three to four radiating lines of scales in each interbrachial space. A few stumps in centre of disk. At each arm joint a double blue cross line,	*Ophiothrix cataphracta.*
	Arms short, three to seven times diameter of disk.	Arm to disk 3 : 1. Upper arm plates narrow, swollen, oval. Lowest arm spine a hook, even at base of arm,	*Ophiothrix pusilla.*
		Arm to disk 3½ : 1. Upper arm plates fan-shaped with inner angle truncated. Lowest arm spine a hook, even at base of arm,	*Ophiothrix exigua.*
		Arm to disk 5 : 1. Disk covered with star-headed stumps, as in the two preceding, but with a few spines mingled. Under arm plates with outer side cleanly curved,	*Ophiothrix stelligera.*
		Arm to disk 4 : 1. Disk beset with forked or trifid stumps without spines. Under arm plates cleanly curved without. Lowest arm spines a hook, even at base of arm,	*Ophiothrix carinata.*
		Arm to disk 7 : 1. Disk beset with slender trifid stumps. Under arm plates as broad as long, curved without, and with converging lateral sides,	*Ophiothrix ciliaris.*
		Arm to disk 5 : 1. Small short, stout stumps, with thorny crowns on upper disk and radial shields. Upper arm plates short, truncated fan-shape, with arm spines encroaching between them,	*Ophiothrix rotata.*
	Arms long and flat, nine to eighteen times diameter of disk.	Arm to disk 9–12 : 1. Disk covering consists of minute stumps, with thorny heads. Similar stumps on upper arm plates,	*Ophiothrix demessa.*
		Upper arm plates with a longitudinal keel. Disk covering consists of minute cylinders. Arm spines with seven thorns on each edge,	*Ophiothrix parasita.*
		Arm to disk 9 : 1. In each interbrachial space are eight to fourteen radiating rows of scales. Disk covering above, thorny stumps, which lengthen below into short spines,	*Ophiothrix hirsuta.*
		Arm to disk 13 : 1. Disk about as in *Ophiothrix longipeda* (same, half grown?), but its stumps are scarcely thorny. The microscopic tuberculation of upper arm plates is also finer,	*Ophiothrix punctolimbata.*
		Arm to disk 18 : 1. Disk about as in *Ophiothrix hirsuta*, but there are about twenty radiating rows of scales in each interbrachial space,	*Ophiothrix longipeda.*

Table of Species of *Ophiothrix*—continued.

Disk flat and regular. Arms narrow and rounded. Arm spines glassy, feebly echinate, needle-like and very long and slender. Arm plates as broad as long.	Radial shields naked.	Four to six arm spines. Very few slender spines on disk. A purple stripe along upper and lower sides of arm, .	*Ophiothrix suensonii.*
		Nine to eleven arm spines. Disk set with needle-like spines and minute stumps. Tentacle scale running along outer edge of arm plate. A green stripe along upper arm, .	*Ophiothrix viridialba.*
		Four to five arm spines. Stout articulated spines on disk, with some very short. A purple line running along upper arm. Disk lined with purple and yellowish, . .	*Ophiothrix purpurea.*
	Radial shields spiny.	Four to five arm spines. Long hair-like spines on disk and radial shields. A white line along upper arm with a purple one on either side, ...	*Ophiothrix comata.*
		Large (disk 22 mm.). Disk and radial shields set with minute stumps, wide brown stripe along upper arm, .	*Ophiothrix capillaris.*
Disk more or less puffed and rounded. Arm spines glassy, not stout nor thick; pretty strongly echinate. Arms stouter than in preceding section.	Radial shields naked.	Numerous trifid, slender stumps on disk; among them a few slender spines. Six slender, strongly echinate arm spines. A dark line along upper arm, ...	*Ophiothrix elegans.*
		Upper disk densely beset with hair-like spines. Eight needle-like arm spines, echinate only at the tip. A radiating black line in each brachial space, ...	*Ophiothrix capensis.*
		Upper disk densely beset with rather coarse spines. Seven to eight somewhat stout, strongly echinate arm spines. (Belongs near *Ophiothrix angulata?*), ...	*Ophiothrix pallida.*
		Upper disk beset with coarse, sharp, echinate spines. Radial shields large. Ten moderately stout very echinate arm spines. Colour pinkish, ...	*Ophiothrix aristulata.*
Of uncertain place.		Similar to *Ophiothrix hirsuta*, but with a glossy disk, .	*Ophiothrix planalata.*
			Ophiothrix cærulea.

Ophiothrix lütkeni, Wyv. Thomson, Depths of Sea, p. 100, 1872.

Station 75.—July 2, 1873; lat. 38° 37′ N., long. 28° 30′ W.; 450 fathoms (young); sand.

Ophiothrix triglochis, Müll. & Tr., Syst. Ast., p. 114, 1842; Ltk., Addit. ad Hist., part 3, p. 59.

Simon's Bay; 5 to 18 fathoms.

Ophiothrix cæspitosa, Lym. (Pl. XXVI. figs. 12–14).

Ophiothrix cæspitosa, Lym., Bull. Mus. Comp. Zool., vol. vi., part 2, p. 53, pl. xv. figs. 417–420, 1879.

Nine short, stout, much flattened, strongly toothed arm spines. The puffed disk and

small radial shields are set with short spines. Upper arm plates transverse diamond-shaped, with lateral angles sharp.

(Type specimen from Port Jackson.) Diameter of disk 7 mm. Length of arm 28 mm. Width of arm near disk 1·5. The vertical oval has about sixteen stout, blunt, nearly equal tooth papillæ, whereof four or five are on the median line, and nearly as large as those on the margin. Four rather thin, squarish teeth, with a cutting edge making an obtuse angle. Mouth shields small, closely joined to surrounding parts, broader than long, of a transverse, rounded oval shape, having a curve without and a very blunt, obtuse angle within. Side mouth shields narrow, wider without than within, where they meet. Under arm plates with ill-marked outlines of a rude, transverse oval form, with a curve without, lateral sides a little indented and the inner side vaguely angular. Side arm plates with a low spine ridge. Upper arm plates much wider than long, transverse diamond-shape, with lateral angles sharp and the outer one rounded; length to breadth, ·5 : 1·1. Disk thick, and puffed in the interbrachial spaces, thickly set near the margin with short, stout stump-like spines rough at ends and sides, the longest ·5 mm. in length. Towards the centre the spines grow fewer, and the middle region has scarcely any, so that the rounded overlapping scaling is conspicuous; next the mouth shields, also, there are no spines. Radial shields small and triangular, much obscured by the short spines. Nine short, translucent, rather stout, blunt, flattened arm spines, bearing pretty strong thorns on their edges; lengths to that of an under arm plate, ·8, 1·5, 1·8, 1·7, 1·3, 1·1, ·9, ·7, ·4 : ·5. One minute tentacle scale at angle of under and side arm plates. Colour in alcohol, above, disk faint greenish; arms banded with lighter and darker yellowish-brown.

Station, Port Jackson; 2 to 10 fathoms.

In its disk this species resembles *Ophiothrix triglochis*, but the arm spines are much flatter and more toothed, and the upper arm plates of a different shape.

Ophiothrix angulata, Ayres, Proc. Bos. Soc. Nat. Hist., vol. iv. p. 249, 1852; Lym., Ill. Cat. Mus. Comp. Zool., No. i. p. 162, pl. ii. figs. 1–3.

Stella marina minor echinata purpurea (?), Sloane, Voyage to Jamaica, p. 272, pl. ccxliv. figs. 8, 9, 1725.
Stella scolopendroides; Jamaicensis purpurea (?), Linck, De Stell. Mar., p. 51, 1733.
Ophiura angulata, Say, Journ. Phil. Acad., vol. v. p. 145, 1825.
Ophiothrix violacea, Müll. & Tr., Syst. Ast., p. 115, 1842; Lym., Ill. Cat. Mus. Comp. Zool., No. i. p. 164; Ltk., Addit. ad Hist., part 2, p. 150, pl. iv. fig. 1.
Ophiura hispida, Ayres, Proc. Bost. Soc. Nat. Hist., vol. iv. p. 249.
Ophiothrix caribœa, Ltk., Vid. Meddel., p. 14, Jan. 1856.
Ophiothrix Kröyeri, Ltk., Vid. Meddel., p. 15, Jan. 1856.

Station 36.—April 23, 1873; off Bermudas; 32 fathoms. Off Bahia; 7 to 20 fathoms (young); var. Fernando Noronha; shallow water; mud.

Ophiothrix longipeda, Müll. (Pl. XLVII. fig. 4).

Ophiothrix longipeda, Müll. & Tr., Syst. Ast., p. 113, 1842; Lym., Ill. Cat. Mus. Comp. Zool. No. i. p. 176; Ltk., Addit. ad Hist., part 3, p. 56.
Ophiura longipeda, Lmk., Hist. Anim. sans Vert., vol. ii. p. 544, 1816.
Ophiure écailleuse, Blainv., Faune Franç. Stell., pls. vi., vii.

The great lobes often noticed in this genus are explained by the immense quantity of eggs with which the interbrachial spaces are stuffed. These masses are traversed by canals leading to the ovarial bursæ. They are figured in Plate XLVII.

Station 186.—September 8, 1874; lat. 10° 30′ S., long 142° 18′ E.; 8 fathoms; coral sand. Ternate Shore.—August 7, 1874. Station 188.—September 10, 1874; lat. 9° 59′ S., long. 139° 42′ E.; 28 fathoms; mud. Tongatabu; 18 fathoms (same species ?). Amboyna; 100 fathoms (same species ?). Samboangan; 10 fathoms.

Ophiothrix pusilla, Lym., Bull. Mus. Comp. Zool., vol. iii., part 10, p. 235, pl. iii. figs. 21–30.

Station 208.—January 17, 1875; lat. 11° 37′ N., long. 123° 32′ E.; 18 fathoms; mud.

Ophiothrix exigua, Lym., Bull. Mus. Comp. Zool., vol. iii., part 10, p. 236, pl. iv. figs. 24–26, 1874.

Station 188.—September 10, 1874; lat. 9° 59′ S., long. 139° 42′ E.; variety ?; 28 fathoms; mud. Station 208.—18 fathoms; mud.

Ophiothrix ciliaris, Müll. & Tr., Syst. Ast., p. 114, 1842; Lym., Bull. Mus. Comp. Zool., vol. iii., part 10, p. 233, pl. iv., figs. 29, 32.

Ophiura ciliaris, Lmk., Hist. Anim. sans Vert., vol. ii. p. 545, 1816.

Station 209.—January 22, 1875; near Cebu; lat. 10° 10′ N., long. 123° 55′ E.; 95 to 100 fathoms; mud.

Ophiothrix stelligera, Lym., Bull. Mus. Comp. Zool., vol. iii., part 10, p. 237, pl. iii. figs. 15–20, 1874.

Arafura Sea (?); August 7, 1874. Station 186.—September 8, 1874; Samboangan, Philippines; lat. 10° 30′ S., long. 142° 18′ E.; 8 fathoms; coral sand.

Ophiothrix propinqua, Lym., Proc. Bost. Soc. Nat. Hist., vol. viii. p. 83, 1861; Ill. Cat. Mus. Comp. Zool., No. i. p. 174; Bull. Mus. Comp. Zool., vol. iii., part 10, p. 234.

Ophiothrix longipeda (young), Ltk., Addit. ad Hist., part 3, p. 56, 1869.

(?) Tongatabu Reefs; 18 fathoms; (red var.). Samboangan (same sp. ?). Fiji, Levuka Reefs.

Ophiothrix nereidina, Müll & Tr., Syst. Ast., p. 115, 1842.

Ophiura nereidina, Lmk., Hist. Anim. sans Vert., vol. ii. p. 554, 1816.

Samboangan, Philippine Islands; 10 fathoms.

Ophiothrix berberis, Lym. (Pl. XXI. figs. 1–4).

Ophiothrix berberis, Lym., Bull. Mus. Comp. Zool., vol. vi., part 2, p. 52, pl. xv. figs. 425–428, 1879.

Seven short, blunt, much flattened, strongly toothed arm spines. Radial shields and interbrachial spaces below nearly or quite naked. Rest of disk set with short stumps bearing a crown of thorns.

(Type specimen from Station 192.) Diameter of disk 9 mm. Width of arm near disk 2·5 mm. Length of arm about 58 mm. The vertical oval has about seventeen stout, blunt, nearly equal tooth papillæ, whereof the marginal ones are scarcely longer than those in the middle. Three squarish, rather thin teeth. Mouth shields broader than long, with an obtuse angle inward and a gentle curve without; length to breadth, 1 : 1·5. Side mouth shields rather narrow, slightly swollen, wider without than within, where they scarcely meet. First under arm plate unusually large, nearly equalling the second, squarish, with rounded corners and an obtuse angle within. The plates increase in size to the seventh, which is broader than long, bounded without by a wide curve, and within by a truncated angle; length to breadth, ·7 : 1·1. Side arm plates furnished with a low thick spine ridge. Upper arm plates transverse diamond shaped, overlapping, having outer angle rounded and inner one truncated; length to breadth, ·7 : 1·4. Disk rather flat, lobed in the interbrachial spaces, which, below, are nearly naked, as are the radial shields, while the remainder of the upper disk is densely covered with short, minute stumps, each bearing a crown of three or four thorns, or, rarely, a fork of two longer thorns. Radial shields long triangular, just touching without, diverging gently inward; length to breadth, 2·7 : 1·7. Seven, short, blunt, much flattened arm spines, bearing strong thorns on their edges; the second one is longest, and those below grow gradually shorter; lengths to that of an under arm plate, 2·3, 3·5, 2·5, 2·2, 1·7, 1·5, ·7 : ·7. One minute tentacle scale. Colour in alcohol, above, disk pale greenish-grey, arms of a faint pink.

Station 192. September 26, 1874; lat. 5° 42′ S., long. 132° 25′ E.; 129 fathoms; mud. Station 209.—January 22, 1875; Cebu, Philippines; lat. 10° 10′ N., long. 123° 55′ E.; 95 to 100 fathoms; mud.

Ophiothrix martensi, Lym., Bull. Mus. Comp. Zool., vol. iii., part 10, p. 234, pl. iv., figs. 9–10, 1874.

August 7, 1874; 6 fathoms.

Ophiothrix trilineata, Ltk., Addit. ad Hist., part 3, pp. 58 and 100, 1869.

Tongatabu Reefs; 18 fathoms.

Ophiothrix melanosticta, Grube, Jahres-Berichte d. Sch. Gesell., p. 45, 1867; Ltk., Addit. ad Hist., part 3, p. 99, 1869.

Station 190.—September 12, 1874; lat. 8° 56′ S., long. 136° 5′ E.; 49 fathoms; mud.

Ophiothrix striolata, Grube, Jahres-Berichte d. Sch. Gesell., p. 45, 1867; Ltk., Addit. ad Hist., part 3, p. 99, 1869.

Station 208.—January 17, 1875; lat. 11° 37′ N., long. 123° 32′ E.; 18 fathoms; mud. Samboangan, Philippines; 10 fathoms.

Ophiothrix suensonii, Ltk., Vid. Meddel., p. 16, 1856; Addit. ad Hist., part 2, p. 148, pl. iv. fig, 2; Lym., Ill. Cat. Mus. Comp. Zool., No. i. p. 157; Bull. Mus. Comp. Zool., vol. v., part 9, p. 232.

Station 36.—April 23, 1873; off Bermudas; 32 fathoms; mud.

Ophiothrix capillaris, Lym. (Pl. XXI. figs. 5–8).

Ophiothrix capillaris, Lym., Bull. Mus. Comp. Zool., vol. vi., part 2, p. 51, pl. xiv. figs. 401–404, 1879.

Very large, with nine very delicate, translucent arm spines, whereof the upper ones are extremely long. Disk set with minute stumps, which are few and scattered on the large radial shields.

(Type specimen from Station 204.) Diameter of disk 22 mm. Width of arm near disk, 4·8 mm. The vertical oval has over fifty tooth papillæ of various sizes, those in the lower half being minute, crowded, and grain-like, while those on the margin of the upper half are large and thick, and project beyond the median papillæ. Four flat teeth, with rounded cutting edge; the uppermost and lowest narrowest. Mouth shields small, much broader than long, bounded by a gentle curve without and an obtuse angle within; length to breadth, ·8 : 1·8. Under arm plates small, narrow, about as long as broad, eight-sided, with angles more or less rounded and lateral sides a little re-enteringly curved. Side arm plates with a well-marked spine ridge. Upper arm plates about as broad as long, of a short diamond-shape, with angles rounded, rising on the median line in a low ridge and microscopically tuberculous. Disk round and flat, scarcely lobed in inter-brachial spaces, more or less closely beset above and below with minute stumps bearing an irregular crown of thorns; on the radial shields they are much more scattered, smaller, and less thorny, and next the genital openings there are none. The radial shields, whose outlines are distinguishable through their covering, are triangular and very large, with a small lobe where they unite over the arm; inwardly they diverge, and sometimes again

bend together so as nearly or quite to reunite; length to breadth, 9 : 4·5. On joints next disk there are nine slender, glassy, translucent, slightly flattened feebly thorny spines, whereof the uppermost are extremely long and elegant; those below progressively shorter; lengths to that of an under arm plate, 15·5, 15, 13, 9, 7, 6, 5, 3, 1·7 : 1·7. One small, blade-like tentacle scale in the angle of the under and side arm plates. Colour in alcohol, above, pale brownish-pink; below, very pale yellowish-brown; along upper side of arm is a wide, brown stripe, whose edges are darkest.

Station 204.—November 2, 1874; lat. 12° 43′ N., long. 122° 10′ E.; 100 to 115 fathoms; mud. Cebu; 100 fathoms.

Ophiothrix capillaris belongs near *Ophiothrix comata* and *Ophiothrix suensonii*. It has an arm stripe like that of the former, but has little stumps on the disk instead of hair-like spines.

Ophiothrix purpurea, V. Mart., Monatsb. König. Akad. Berlin, p. 346, 1867; Lym., Bull. Mus. Comp. Zool., vol. vi., part 2, p. 54.

Station 177.—August 18, 1874; lat. 16° 45′ S., long. 168° 5′ E.; 63 fathoms (?). Station (?) Banda.

Ophiothrix aristulata, Lym. (Pl. XXI. figs. 9–12).

Ophiothrix aristulata, Lym., Bull. Mus. Comp. Zool., vol. vi., part 2, p. 50, pl. xv. figs. 421–424, 1879.

Ten moderately stout, feebly thorny, scarcely tapering arm spines. Disk, except the large radial shields, densely set with short, slightly rough spines.

(Type specimen from Station 142.) Diameter of disk 14 mm. Width of arm near disk 3 mm. There are about thirty tooth papillæ which are pointed, and are arranged, as usual, in a vertical oval, the exterior line on either side composed of ten or eleven longer ones, while a similar number of shorter ones, arranged in twos at the centre, and in a single line above and below, fill closely the middle space. Three short, thick, squarish teeth. Mouth shield well marked, of a transverse diamond shape, with rounded corners. Side mouth shields thick and slightly swollen, rather wide, nearly or quite meeting within, taperingly gently inward. Under arm plates somewhat wider than long, with a wide curve without, short re-enteringly curved laterals, and straight inner laterals sloping towards the median line. Side arm plates presenting a moderately prominent spine crest. Upper arm plates wider than long, slightly overlapping, of a transverse diamond shape, with corners rounded or truncated; each plate has a median ridge, which gives to the upper arm a carinate look. Disk thick and strongly lobed in the interbrachial spaces; its upper surface occupied chiefly by large radial shields, which are long triangular, with a length to breadth of 5 : 3; they unite without, where each

has a lobe projecting over the arm, separated within by a narrow wedge of scales bearing one or two rows of short, slightly rough spines: similar but somewhat longer spines densely clothe the centre and interbrachial spaces, passing over the margin and investing the outer portion of the naked surface below; the longest spines are 1·7 mm. Ten moderately stout, scarcely tapering, somewhat flattened, trauslucent arm spines, bearing feeble thorns on their edges; the uppermost and lowest are minute, the rest diminish in length from the third downward; lengths to that of an under arm plate ·8, 3·6, 4·6, 3·6, 3, 3, 2·6, 2, 1, ·8 : 1. The first tentacle pore has no scales; those beyond have a minute lip-like one in the angle of the under and side arm plates. Colour in alcohol, above, pale purplish pink, the side arm plates and outer edges of radial shields marked with darker; below much paler.

Station 142.—December 18, 1873; lat. 35° 4′ S., long. 18° 37′ E.; 150 fathoms; sand. Station 161.—April 1, 1874; off Entrance to Port Philip (var. with coarser spines); 38 fathoms; sand. Station 163.—April 4, 1874; off Twofold Bay (var.); 120 fathoms; red clay.

The species is readily distinguished from *Ophiothrix capensis* by lacking the black stripe on the arm, and by having arm spines serrated their whole length.

Species of *Ophiothrix* not herein described.

Ophiothrix fragilis, Düb. & Kor., Öf. Skandinav. Echin., 1846, p. 238; Lym., Bull. Mus. Comp. Zool., vol. iii., part 10, p. 249; Ludwig, Echin. des Mittelmeeres, p. 551.

Asterias fragilis, Abildg. (Müller), Zool. Dan., p. 28, pl. xeviii., 1789.
Ophiothrix Rammelsbergii, Müll. & Tr., Syst. Ast., p. 113, pl. viii. fig. 3.
Ophiothrix alba (?), Grube, Wieg. Archiv, p. 344, 1857.
Ophiothrix fragilis (pars), Sars, Ltk., Addit. ad Hist., part 3, p. 52, 1869.

North European Seas; 6 to 52 fathoms.

Ophiothrix echinata, Müll. & Tr. (non. Ltk. nec. Ljn.), Syst. Ast., p. 111, 1842; Lym., Bull. Mus. Comp. Zool., vol. iii., part 10, p. 249; Ludwig, Echin. des. Mittelmeeres, p. 552.

Asterias echinata, Delle Chiaje, Mem., vol. iii. p. 79, pl. xxxiv. fig. 5, 1823–29.
Ophiothrix echinophora, Müll. & Tr., Wieg. Archiv, vol. vi. p. 328, 1840.
Asterias tricolor (?), Delle Chiaje, Mem., vol. iii., pl. xxxiv. fig. 9.
Asterias pentagona (?), vol. iii., pl. xxxiv. fig. 15.
Asterias Ferussaci (?), vol. ii., p. 79, pl. xxxiv. fig. 12.
Asterias Cuvieri (?), vol. iii., pl. xxxiv. fig. 17.
Ophiothrix rubra (?), Ljn., Dr. Goës, Oph. Öf Kong. Akad., p. 624, 1871.

Adriatic and Mediterranean; littoral.

Ophiothrix pentaphyllum, Ljn., Dr. Goës, Oph. Öf. Kong. Akad., p. 622; Lym., Bull. Mus. Comp. Zool., vol. iii., part 10, p. 249.

Asterias pentaphyllum, Pen., Brit. Zool., vol. iv. pp. 54, 55, 1812.
Ophiocoma rosula, Fbs., Brit. Starfishes, p. 60, 1841.

South of England; North and West of France; littoral.

Ophiothrix alopecurus, Müll. & Tr., Syst. Ast., p. 111, 1842; Lym., Bull. Mus. Comp. Zool., vol. iii., part 10, p. 249; Ludwig. Echin. des Mittelmeres, p. 551.

Ophiothrix fragilis (?), Müll & Tr. (non *Asterias*, Abildg.), Syst. Ast., p. 110.
Ophiothrix fragilis (var. *tenuispina*), Sars, Mid. Lit. Fauna, vol. ii., p. 74, 1857.
Ophiothrix echinata, Ltk. (non Müll. & Tr. nec Ljn.), Addit. ad Hist., part 3, pp. 52 and 104, 1869.

Trieste; North Adriatic; littoral.

Ophiothrix lusitanica, Ljn., Dr. Goës, Oph. Öf. Kong. Akad., p. 625, 1871; Lym., Bull. Mus. Comp. Zool., vol. iii., part 10, p. 249; Ludwig, Echin. des Mittelmeeres, p. 551.

Ophiothrix rubra (?), Ljn., Dr. Goës, Oph. Kong. Akad., p. 624.

Portugal; North-West Coast of France; Naples.

Ophiothrix maculata, Ljn., Dr. Goës, Oph. Öf. Kong. Akad., p. 623, 1871; Lym., Bull. Mus. Comp. Zool., vol. iii., part 10, p. 250.

Portugal; 120 fathoms.

Ophiothrix roseo-cærulans, Grube, Jahres-Berichte d. Sch. Gesell., p. 45, 1867.

St. Helena.

Ophiothrix quinquemaculata, Müll. & Tr. (Pl. XLII. figs. 5-8), Syst. Ast., p. 112, 1842; Lym., Bull. Mus. Comp. Zool., vol. iii., part 10, p. 249; Ludwig. Echin. des Mittelmeeres, p. 552.

Asterias quinquemaculata, Delle Chiaje, Mem., vol. iv., p. 209, pl. lxviii. fig. 1, 1823-29; Müll. & Tr., Wieg. Archiv, vol. vi. p. 329, 1840.

West Coast of Italy; littoral.

Ophiothrix fumaria, Müll. & Tr., Syst. Ast., p. 113, 1842; Lym., Bull. Mus. Comp. Zool., vol. iii., part 10, p. 223, pl. iv. figs. 33-36.

Ophiura ciliaris (pars), Lmk., Hist. Anim. sans Vert., vol. ii. p. 545, 1816.

Ophiothrix örstedii, Ltk., Vid. Meddel., 1856, p. 15; Addit. ad Hist., part 2, p. 149, pl. iv. fig. 3; Lym., Ill. Cat. Mus. Comp. Zool., No. i. p. 154; Bull. Mus. Comp. Zool., vol. v., part 9, p. 233.

West Indies; littoral.

Ophiothrix spiculata, Le Conte, Proc. Phil. Acad., vol. v. p. 318, 1851; Ltk., Addit. ad Hist., part 2, p. 151; Lym., Ill. Cat. Mus. Comp. Zool., No. i. p. 167; Vll., Trans. Conn. Acad., vol. i., part 2, p. 267.

West Coast of Central America; littoral.

Ophiothrix koreana, Duncan, Linn. Soc. Journ., vol. xiv. p. 473, pl. xi. figs. 28–32, 1878.

Korean Straits; 23 fathoms.

Ophiothrix magnifica, Lym., Proc. Bost. Soc. Nat. Hist., vol. vii. p. 254, 1860; Ill. Cat. Mus. Comp. Zool., No. i. p. 159, 1865.

Chili; littoral.

Ophiothrix rudis, Lym., Bull. Mus. Comp. Zool., vol. iii., part 10, p. 239, pl. iii. figs. 11–14, 1874.

San Diego, California; littoral.

Ophiothrix dumosa, Lym., Proc. Bost. Soc. Nat. Hist., vol. vii. p. 252, 1860; Ill. Cat. Mus. Comp. Zool., No. i. p. 169, 1865.

Gulf of California; littoral.

Ophiothrix lineata, Lym., Proc. Bost. Soc. Nat. Hist., vol. vii. p. 201, 1860; Ill. Cat. Mus. Comp. Zool., No. i. p. 171; Bull. Mus. Comp. Zool., vol. v., part 9, p. 233.

Florida; littoral to 20 fathoms.

Ophiothrix demessa, Lym., Proc. Bost Soc. Nat. Hist., vol. viii. p. 82, 1861; Ill. Cat. Mus. Comp. Zool., No. i. p. 172.

Kingsmill Islands, Pacific; littoral.

Ophiothrix parasita, Müll. & Tr., Wieg. Archiv, vol. xiv. p. 184, 1844.

Australia.

Ophiothrix hirsuta, Müll. & Tr., Syst. Ast., p. 111, 1842; Lym., Ill. Cat. Mus. Comp. Zool., No. i. p. 176, 1865.

Ophiothrix Cheneyi, Lym., Proc. Bost. Soc. Nat. Hist., vol. viii. p. 84, 1861; Ill. Cat. Mus. Comp. Zool., No. iii. p. 175.

Great Ocean; littoral.

Ophiothrix punctolimbata, V. Mart., Wieg. Archiv, vol. xxxvi. p. 257, 1870.
Java.

Ophiothrix rotata, V. Mart., Wieg. Archiv, vol. xxxvi. p. 258, 1870.
Mindanao.

Ophiothrix planulata, Stimp., Proc. Phil. Acad., vol. vii. p. 386, 1855.
Groper Shoal, 20° S., 160° 30′ E.

Ophiothrix carinata, V. Mart., Wieg. Archiv, vol. xxxvi. p. 255, 1870.
Singapore.

Ophiothrix aspidota, Müll. & Tr., Syst. Ast., p. 115, 1842; Lym., Bull. Mus. Comp. Zool., vol. iii., part 10, p. 234.
East Indies.

Ophiothrix triloba, V. Mart., Wieg. Archiv, vol. xxxvi. p. 260, 1870.
Red Sea.

Ophiothrix galateæ, Ltk., Oph. Nov. Descr. Vid. Selsk. Forh., p. 108, 1872.
Nicobar Islands.

Ophiothrix cataphracta, V. Mart., Wieg. Archiv, vol. xxxvi. p. 259, 1870.
Singapore.

Ophiothrix cærulea, Hutt., Ech. New Zealand, p. 1, 1872.
New Zealand.

Ophiothrix spongicola, Stimp., Proc. Phil. Acad., vol. vii. p. 385, 1855.
Port Jackson, Australia.

Ophiothrix virgata, Lym., Proc. Bost. Soc. Nat. Hist., vol. viii. p. 82, 1861; Ill. Cat. Mus. Comp. Zool., No. i. p. 161.
Kingsmill Islands; littoral.

Ophiothrix elegans, Ltk., Addit. ad Hist., part 3, pp. 57 and 99, 1869.
New Guinea; China Sea; littoral.

Ophiothrix pallida, Ljn., Dr. Goës, Oph. Öf. Kong. Akad., p. 626, 1871.
Anguilla, West Indies; 180 fathoms.

Ophiothrix comata, Müll. & Tr., Syst. Ast., p. 112, 1842; Lym., Bull. Mus. Comp. Zool., vol. iii., part 10, p. 233.

Locality unknown.

Ophiothrix capensis, Ltk., Addit. ad Hist., part 3, pp. 59, 100, 1869.

Cape of Good Hope.

Ophiothrix viridialba, V. Mart., Monatsb. König. Akad. Berlin, p. 347, 1867.

China Sea; 40 fathoms.

Ophiothrix plana, Lym., Bull. Mus. Comp. Zool., vol. iii., part 10, p. 238, pl. iv. figs. 1–8, 1874.

Philippines; Macassar; littoral.

Ophiogymna.

Ophiogymna, Ljn., Om några nya arter, Öf. Kong. Akad., 1866.

Disk covered with a thick skin which hides all the radial shields except their outer ends, and has embedded in it loose, ill-defined scales. Numerous crowded tooth papillæ, forming a vertical oval. Teeth. No mouth papillæ. Spines numerous (five to ten) (often three times as long as the joints), flattened, more or less glassy, thorny, having a central shaft with slender side spurs from it. A small spine-like tentacle scale. The base of the jaw pierced with a hole, from a want of perfect union between the two pieces of the mouth frames. Interbrachial spaces swelled out like lobes. Two genital openings beginning outside the mouth shields. Outer arm joints with hooks.

In internal structure the genus does not materially vary from *Ophiothrix*.

Ophiogymna elegans, Ljn., Om några nya arter, Öf. Kong. Akad., p. 163, 1866; Oph. Viv. Öf. Kong. Akad., p. 333, 1866; Ltk., Addit. ad Hist., part 3, p. 60, 1869.

Station 203.—October 31, 1874; lat. 11° 7′ N., long. 123° 7′ E.; 12 to 20 fathoms; mud.

Ophiocnemis.

Ophiocnemis, Müll. & Tr., Syst. Ast., 1842.

Disk covered by very large naked radial shields, and minute plates bearing numerous grains. On the interbrachial spaces below, a fine scaling. Numerous crowded tooth papillæ forming a vertical oval. Teeth. No mouth papillæ. Arm spines numerous, rounded, microscopically fluted, not translucent, a little hollow in the centre. The base

of the jaw pierced with a vertical hole. Interbrachial spaces somewhat swelled. Two large genital openings beginning outside the mouth shields.

The skeleton belongs strictly to the group of *Ophiothrix* with its peculiarities exaggerated. Thus the special apophysis extending outwards from the outer surface of the arm bones is larger and more spreading, so that it really is locked into the slot in the following bone (Pl. XLII. fig. 14). The upper surface of the arm bones is, moreover, longer, and, together with the margin, is deeply grooved. In general appearance the genital plate is like that in *Ophiothrix*, and its scale (*n*), seen edgewise in the figure, has a corresponding shape. The high and deeply grooved wings of the mouth frames (*f*) are a further exaggeration of the type, and the regular and very large radial shields are quite as important as in *Ophiothrix suensonii*. Fig. 15 shows a mouth angle and two arm joints from the under side, and exhibits the separation of the two halves of the jaw (*c*) characteristic of the *Ophiothrices*, together with the cup-like socket (*r'*) of the second mouth tentacle.

See Plate XLII. figs. 14, 15.

Species of *Ophiocnemis* not herein described.

Ophiocnemis marmorata, Müll. & Tr., Syst. Ast., p. 87, 1842, pl. xlii. figs. 14, 15; Lym., Ill. Cat. Mus. Comp. Zool., No. i. p. 152; Bull. Mus. Comp. Zool., vol. iii., part 10, p. 234.

Ophiura marmorata, Lmk., Hist. Anim. sans Vert., vol. ii. p. 543.
Ophiothrix clypeata (young), Ljn., Oph. Viv. Öf. Kong. Akad., p. 163, 1866.

Great Ocean.

Ophiomaza.

Ophiomaza, Lym., Ill. Cat. Mus. Comp. Zool., No. vi., 1871

Disk above covered by very large naked radial shields and by plates. On the interbrachial spaces below, a fine scaling. Numerous crowded tooth papillæ forming a vertical oval. Teeth. No mouth papillæ. Arm spines numerous, rounded, not translucent, solid. The base of the jaw pierced with a vertical hole. Interbrachial spaces somewhat swelled. Two large genital openings beginning outside the mouth shields.

The skeleton belongs strictly with the *Ophiothrices*, and most resembles that of *Ophiocnemis*.

Ophiomaza cacaotica, Lym., Ill. Cat. Mus. Comp. Zool., No. vi., p. 9, pl. i. fig. 15, 1871; Bull. Mus. Comp. Zool., vol. iii., part 10, p. 233.

Station 187.—September 9, 1874; lat. 10° 36′ S., long. 141° 55′ E.; 6 fathoms; coral sand.

Species of *Ophiomaza* not herein described.

Ophiomaza obscura, Lym., Bull. Mus. Comp. Zool., vol. iii., part 10, p. 233.

Ophiocnemis obscura, Ljn., Oph. Viv. Öf. Kong. Akad. p. 333, 1866.

Singapore.

Ophiothela.

Ophiothela, Vll., Trans. Conn. Acad., vol. i., 1867.

Disk covered by very large naked radial shields and a few irregular scales. Numerous crowded tooth papillæ forming an irregular vertical oval. Teeth. No mouth papillæ. Arm spines thorny, clubbed and very short, borne on pad-like side arm plates which stand out free from the arm. Upper arm plates broken in irregular pieces, or represented by several wart-like swellings. The base of the jaw is pierced with a vertical hole. Interbrachial spaces somewhat swollen. Two large genital openings beginning outside the mouth shields.

The skeleton is like that of *Ophiothrix*.

Table of Species of *Ophiothela*.

Radial shields large. Interbrachial spaces set with short, thick spines. Six arms whose upper surface bears grains or minute spines, ...	*Ophiothela mirabilis.*
Radial shields large, and interbrachial spaces very narrow, and smooth or set with a few grains. Six arms, whose upper surface is sparsely granulated, . .	*Ophiothela danæ.*
Disk above covered wholly by large smooth radial shields. Five arms which have a few warts or grains on their upper surface, ...	*Ophiothela tigris.*
Disk covered by a thick skin, set with scattered grains which obscure the large radial shields. Six arms, whose upper surface bears larger and smaller grains, . .	*Ophiothela isidicola.*
Disk with radial shields of moderate size, so that there is a free central space which with the shields bears thorny grains; and these are continued along the tops of the six arms, ...	*Ophiothela dividua.*

Species of *Ophiothela* not herein described.

Ophiothela mirabilis, Vll., Trans. Conn. Acad., vol. i. p. 268, 1867.

Panama Bay.

Ophiothela danæ, Vll., Proc. Bost. Soc. Nat. Hist., vol. xii. p. 391, 1869.

Fiji Islands.

Ophiothela tigris, Lym., Ill. Cat. Mus. Comp. Zool., No. vi. p. 10, pl. i. figs. 10–12, 1871.

U.S. Pacific Exp. Expedition?

Ophiothela isidicola, Ltk., Oph. Nov. Descr. Vid. Selsk. Forh., p. 107, pl. ii. figs. 4–4*g*, 1872; Lym., Ill. Cat. Mus. Comp. Zool., No. viii. part 2, pl. iv. fig. 60.
Strait of Formosa.

Ophiothela verrilli, Duncan, Journ. Linn. Soc., vol. xiv., p. 477, pl. xi. fig. 33, 1879.
Korean Sea.

Ophiothela dividua, V. Mart. Sitzungsber, Berlin, Gesell. Nat. Fr., p. 127, 1879.
Algoa Bay.

Ophiopsammium.

Ophiopsammium, Lym., Bull. Mus. Comp. Zool., vol. iii. p. 10, 1874.

Teeth. Tooth papillæ numerous, and arranged in a vertical, oval clump, as in *Ophiothrix*. No mouth papillæ. Disk and arms covered by smooth, naked skin below, but closely granulated above. Arm spines stout and thorny, mounted on a crest-like side arm plate, as in *Ophiothrix*. Tentacles long, covered with papillæ, and issuing, not from the under surface, but from the side of the arm.

This genus is nearest *Ophiothela*, but differs in having the whole upper surface closely granulated, as also in the side arm plates.

The internal skeleton is nearly that of *Ophiomaza*, with similar very large, regular, radial shields.

Species of *Ophiopsammium* not herein described.

Ophiopsammium semperi, Lym., Bull. Mus. Comp. Zool., vol. iii., part 10, p. 232, 1874, pl. iv. figs. 11–17.
Philippines; littoral.

Ophioblenna.

Ophioblenna, Ltk., Addit. ad Hist., part 2, 1859.

Disk covered by a naked skin. Teeth. No tooth papillæ. Numerous close-set, spine-like mouth papillæ. Numerous (six to seven) flat, pointed, glassy, slightly thorny arm spines. Two genital openings in each interbrachial space, beginning just outside the mouth shields.

It is not a little curious that the two specimens at Copenhagen of this littoral genus still remain unique. Among the immense collections brought from all parts of the West Indies I have failed to recognise a single individual. Of its skeleton I am quite ignorant.

Species of *Ophioblenna* not herein described.

Ophioblenna antillensis, Ltk., Addit. ad Hist., part 2, p. 137, pl. iv. fig. 4, 1859. West Indies.

Ophioscolex.

Ophioscolex, Müll. & Tr., Syst. Ast., 1842.

Disk covered by a thick naked skin, which conceals the very fine underlying scaling, and which is continued over the arms. There are teeth and mouth papillæ, and in some species (*Ophioscolex glacialis*) a few tooth papillæ. Arm spines smooth and covered with thin skin. No upper arm plates. Two genital openings in each interbrachial space.

Seen from the inside, the apparently naked disk skin is found to cover a delicate coat of very fine scales. Just by the arm, at the margin of the disk is a very small flat slightly curved radial shield (Pl. XLII. fig. 2, *l*), and connected with it, a miniature genital scale (*n*), flat and curved, and a genital plate (*o*), with a rounded tapering shaft, and a clubbed head. This apparatus is smaller than in any other genus. The arm bones are peculiar; they are long and flat on top with a shallow median canal (fig. 2, *w'*), while their lower surface is, on the contrary, strongly grooved for the central canal, and the tentacle sockets and muscle fields are deep hollows. Their outer and inner faces are low and wide, with a minute articulating peg, above which rises a large shoulder to receive the umbo of the next bone. Not less peculiar are the mouth frames (fig. 3, *f*), which, instead of being more or less flaring, as is usual, are compact, destitute of wings, and almost cylindrical. They are prolonged inward by three peristomial plates, two inclined to each other and the third filling the open angle (fig. 3 *v,v*), which are of such size as completely to cover the mouth angle, except the minute jaw plate which carries sharp, spine-like teeth (*d''*). In its lower aspect the mouth angle is large, with a small mouth shield (fig. 4, *a*) and large long side mouth shields.

See Plate XLII. figs. 2–4.

Table of Species of *Ophioscolex*.[1]

About seven small peg-like mouth papillæ to each angle. No tentacle scale,	*Ophioscolex glacialis.*
About eleven small peg-like mouth papillæ to each angle. One small tentacle scale,	*Ophioscolex purpureus.*
Nine sharp, conical mouth papillæ to each angle. A long flap of skin in place of a tentacle scale,	*Ophioscolex stimpsonii.*
Fifteen mouth papillæ to each angle, whereof the three outer ones are long, flat, spiniform. One tentacle scale,	*Ophioscolex dentatus.*
Seventeen to nineteen small, close-set, tooth-like mouth papillæ to each angle. One tentacle scale, sometimes none,	*Ophioscolex tropicus.*

[1] *Ophioscolex coppingeri*, Bell., Proc. Zool. Soc., June 4, 1881, p. 98; West Coast of Patagonia. This species is described as having dorsal plates on the arms, but Professor Bell has since written me that these are really the upper sides of the arm bones.

Ophioscolex dentatus, Lym. (Pl. XXIV. figs. 4–6).

Ophioscolex dentatus, Lym., Bull. Mus. Comp. Zool., vol. v., part 7, p. 157, pl. vii. figs. 184–186, 1878.

Three or four short, blunt, flattened, arm spines. Numerous mouth papillæ, whereof the outer are flat, spiniform. One tentacle scale.

(Type specimen from Station 142.) Diameter of disk 15 mm. Length of arm about 55 mm. Width of arm, without spines, close to disk 2·7 mm. There are seven mouth papillæ on each side of an angle and one small and pointed at apex of jaw; the three outer are flat, spiniform, and much the largest and longest. On removing the skin the mouth shield is seen to be wide triangular, having an obtuse angle within and outer corners rounded. Side mouth shields long, narrow, and meeting within. Arms covered by a thick skin completely hiding the plates, which are obscurely indicated below by transverse furrows. On removing the skin, the under arm plates appear longer than wide, with a curve without and a re-entering curve within; the side arm plates small and meeting neither above nor below, while the upper plates are only indicated by thin films of slightly calcified skin. Disk round and rather flat, covered with a soft naked skin variously wrinkled above and below. Genital openings wide and long, extending from the mouth shield to the edge of the disk. Three or four short, blunt, flattened arm spines, equally spaced, about as long, as an arm joint; the upper and undermost usually a little the longest. One small rounded tentacle scale on the inner side of the pore. Colour in alcohol, light grey.

Station 142.—December 18, 1873; off Agulhas Bank; lat. 35° 4′ S., long. 18° 37′ E.; 150 fathoms; sand.

Ophioscolex tropicus, Lym. (Pl. XXIV. figs. 1–3).

Ophioscolex tropicus, Lym., Bull. Mus. Comp. Zool., vol. v., part 7, p. 157, pl. vii. figs. 190–192, 1878.

Seventeen to nineteen small, short, pointed close-set mouth papillæ, occupying the entire margin of each mouth angle. Whole animal covered by a thick skin, through which appear the lower and side arm plates, the mouth shields, and (indistinctly) the scaling of the lower interbrachial space.

(Type specimen from Station 24.) Diameter of disk 8 mm. Width of arm close to disk, without spines, 1·3 mm. Eight or nine short, close-set, rounded mouth papillæ, occupying the whole length of each side, and one larger and more pointed at apex of jaw. Mouth shields much broader than long, in shape transverse oval; length to breadth, ·6 : 1·2. Side mouth shields long, curved and narrow, broader without, tapering inward, where they do not quite meet. First under arm plate very small, nearly square, the others larger, long hexagonal, with outer side curved, lateral sides re-enteringly curved,

and three inner sides short. Side arm plates broad and thin, meeting near base of arm, neither above nor below. The place of the upper arm plates is occupied by thick skin, through which may be distinguished the upper side of the arm bones. Disk flat and thin, covered with a thick, slightly wrinkled skin, which conceals the radial shields and the fine scaling, though the latter may be distinguished in the lower interbrachial spaces. Genital scales quite hidden. Genital opening extending from the mouth shield to the margin of the disk. Three cylindrical, stout, nearly equal, pointed arm spines, about as long as an arm joint. One small rounded tentacle scale on inner side of the tentacle pore. Colour in alcohol, grey.

I admit this species to *Ophioscolex* with some hesitation. The mouth papillæ are different in shape and arrangement; but the absence of upper arm plates and the characteristic covering of smooth skin suggest its position.

Station 24.—March 25, 1873; off Culebra; 390 fathoms; mud.

Species of *Ophioscolex* not herein described.

Ophioscolex coppingeri, Bell, Proc. Zool. Soc., Jan. 1881, p. 98, pl. viii. fig. 6.
West Coast Patagonia.

Ophioscolex glacialis, Müll. & Tr., Syst. Ast., p. 109, 1842, pl. xlii. figs. 2–4.
Arctic European Seas and North America; 100–300 fathoms.

Ophioscolex purpureus, Düb. & Kor., Öf. Skandinav. Echin., p. 235, 1844; Ljn. Oph. Viv. Öf. Kong. Akad., p. 327; Lym., Bull. Mus. Comp. Zool., vol. v. part 9, p. 233.
West Indies; 190 fathoms. Norway.

Ophioscolex stimpsonii, Lym., Ill. Cat. Mus. Comp. Zool., No. viii., part 2, p. 23, 1875; pl. i. figs. 11–15.
Off Sombrero Key, Florida; 240 fathoms.

Ophiambix.

Ophiambix, Lym., Anniv. Mem. Bost. Soc. Nat. Hist., 1880.

Disk flat; arms wide and flat; and both beset above with sharp grains, or spines. No radial shields or upper arm plates externally visible. Small, sharp, mouth papillæ and teeth; no tooth papillæ. Tentacle pores very large. Side arm plates widely separated above and below, but occupying a considerable part of under surface of arm. Arm spines translucent, hollow, and with an uneven surface.

Ophiambix aculeatus, Lym. (Pl. XXVII. figs. 10–12).

Ophiambix aculeatus, Lym., Anniv. Mem. Bost. Soc. Nat. Hist., pl. ii. figs. 29–31, 1880.

On upper side of disk and arms, sharp grains, which increase to short spines on margin. Interbrachial spaces below delicately scaled. Three sharp arm spines.

Diameter of disk 5 mm. Width of arm without spines 1·5 mm. The rather small jaws, which are separated at their outer ends, bear each three or four small, sharp, translucent papillæ, while the apex is occupied by the lowest tooth, which is peg-shaped and much larger than the papillæ. Mouth shields very small, of a transverse oval shape, with a slight peak within. Side mouth shields short and small, tapering at each end, and wedged between outer ends of jaws. First under arm plate nearly as large as those beyond, somewhat longer than broad, bounded within by an obtuse angle, without by a gentle curve, and, on the lateral sides, by re-entering curves. Length to breadth of fourth plate, 0·6 : 0·5. The wide space on either side of the under arm plates is occupied partly by the very large tentacle sockets, and partly by the side arm plates which make narrow partitions between the tentacles, and then enlarge into a strong but very low spine crest. Upper surface of arm covered by skin, and evenly set with sharp, conical grains, about eight in the length of 1 mm. Disk much flattened, and somewhat puffed in the interbrachial spaces; evenly set above with sharp conical grains, which are similar to those of the arm, and which are continued as minute conical spines, over the margin. Interbrachial spaces below destitute of spines and covered by a thin, delicate scaling. No radial shields are externally visible. Genital openings large, extending from outer corner of mouth shield to margin of disk. The extremely flattened arm bears, on either side, three translucent, hollow, slightly flattened, sharp, tapering arm spines, whereof the two upper are as long as two joints, and the lowest about two-thirds as long. Three or four short, sharp, spine like tentacle scales, standing on the margin of the very large pores, from which protrude simple club ended tentacles.

Colour in alcohol, straw.

Station 175.—August 12, 1874; near Fiji Islands; lat. 19° 2′ S., long. 177° 10′ E.; 1350 fathoms; red clay.

Ophiosciasma.

Ophiosciasma, Lym., Bull. Mus. Comp. Zool., vol. v., part 7, 1878.

Disk covered with thick soft skin, finely granulated. Arms very slender and knotted, with lower and side plates imperfectly calcified, and no upper plates. Mouth papillæ and teeth represented by a bunch of spines, or thorns, at apex of jaw. Arm spines few (3), small and short. Two large genital openings in each interbrachial space.

A singular genus, which, by its disk covered with soft skin and lack of upper arm

plates, is allied to *Ophioscolex*, but differs by its granulation and its extremely slender, knotted arms.

It is a low genus, and, like *Ophiogeron*, has the embryonic arm bone nearly divided into its halves, a condition more fully exemplified in *Ophiotholia*.

Ophiosciasma attenuatum, Lym. (Pl. X. fig. 13, Pl. XVI. figs. 1–3).

Ophiosciasma attenuatum, Lym., Bull. Mus. Comp. Zool., vol. v., pt. 7, p. 160, pl. vii. figs. 193–195.

Disk beset with a very fine but not continuous granulation. Arms very slender, knotted, and at centre of the joints diaphanous. Three small, nearly equal arm spines.

(Type specimen from Station 122.) Diameter of disk 6 mm. Length of arm 45 mm. Width of arm without spines 6 mm Mouth papillæ, teeth, and tooth papillæ combined in form of a clump of seven or eight sharp thorns or spines, standing round the apex made by the juncture of the long narrow mouth frames. Mouth shields of a transverse diamond shape, very small, sometimes scarcely visible, more or less hidden by thick skin. Side mouth shields very narrow and slender, meeting within. Under arm plates very thin, and in their central part transparent, so that their outlines are vague, longer than broad, with outer side slightly curved and lateral sides re-enteringly curved; length to breadth, ·5 : ·4. Side arm plates reduced to a strip, like a double cord, running along the side of the joint. No upper arm plates. The arm bones are but slightly calcified, except at their thickened ends, so that their more slender central shaft is translucent. The arm thus presents a beaded appearance, with swellings where the ends of the arm bones form joints and support the arm spines. Disk covered with a thick skin, which above is beset with fine grains, and which partly obscures the mouth papillæ and the arm spines. No radial shields or disk scales visible. Three small, blunt, nearly equal arm spines, not so long as an arm joint, seen to be microscopically rough when free of skin, and standing nearly at right angles to arm. Tentacles large, simple, and fleshy; no tentacle scales. Colour in alcohol very pale yellow.

The animal is covered by a thick, translucent skin, which passes also over the arm spines. There are six slender, knotted arms, four larger and two smaller.

Station 122.—September 10, 1873; lat. 9° 5′ S. to 9° 10′ S., long. 34° 49′ W. to 34° 53′ W.; 350 fathoms; mud.

Ophiogeron.

Ophiogeron, Lym., Bull. Mus. Comp. Zool., vol. v., part 7, 1878.

Disk covered by a naked skin. Mouth angles naked, except a few small teeth on jaw plate. Under arm plates small, and with a large tentacle pore on either side. Side arm plates somewhat flaring, and carrying thorny arm spines covered with skin. No upper arm plates.

This genus is somewhat allied with *Ophiomyxa* and with *Ophioscolex*.

Ophiogeron edentulus, Lym. (Pl. XII. figs. 16–18), Bull. Mus. Comp. Zool., vol. v., part 7, p. 161, pl. vii. figs. 187–189, 1878.

Two or three feeble pointed teeth; otherwise the mouth angle quite naked. Two stout arm spines, which, stripped of skin, show longitudinal rows of hooked thorns.

(Type specimen from Station 175.) Diameter of disk 3 mm. Length of arm about 14 mm. Width of same close to disk, without spines, 1 mm. Mouth angles quite naked, except one small pointed papilla at apex of jaw and two or three more that represent teeth. Mouth shields rounded triangular; length and breadth about equal, with an angle within, and outer side rounded. Side mouth shields rather large, curved, longer than wide, broadest within, where they meet. First under arm plate narrow, five-sided, with inner edge straight, a broad angle without, and re-entering curves on the lateral sides, second plate similar, but narrower and with the angle inward. Those beyond are further modified by having the outer and inner sides curved. Side arm plates broad and meeting below, beyond the second under arm plate; flaring somewhat toward their outer edge. The arm plates and mouth shields are more or less obscured by thick skin. Along the upper side of the arm the central ridge of the arm bones shows through the skin. Disk flat and thin, completely covered with a naked wrinkled skin. Two short tapering arm spines, which when stripped of skin present longitudinal rows of slightly hooked thorns. No tentacle scales, but large pores from which long smooth tentacles protrude. Colour in alcohol, greyish.

Station 76.—July 3, 1873; lat. 38° 11′ N., long. 27° 9′ W.; 900 fathoms; globigerina ooze. Station 175.—August 12, 1874; lat. 19° 2′ S., long. 177° 10′ E.; 1350 fathoms; red clay.

Ophiohelus.

Ophiohelus, Lym., Anniv. Mem. Bost. Soc. Nat. Hist., 1880.

Disk covered with a delicate, film-like scaling, without radial shields. Arm bones composed of two halves like curved bars, lying side by side, joined at their ends and enclosing an oval hole. Mouth papillæ spiniform and arranged in a single row; teeth similar; no tooth papillæ. On the outer joints of the arm, the true arm spines cease, and are replaced by two or more rows of minute spines or pedicellariæ, which have the form of a long-handled parasol.

Ophiohelus pellucidus, Lym. (Pl. XXVIII. figs. 5–9).

Ophiohelus pellucidus, Lym., Anniv. Mem. Bost. Soc. Nat. Hist., pl. i. figs. 11–15, 1880.

Parasol spines short and stout; in two rows, three or four in a row. Disk smooth. No tentacle scales.

Diameter of disk 4 mm. Length of arm 12 mm. Width of arm without spines 1 mm. Mouth angles prominent and separated by wide mouth slits; at apex is a thick, rounded jaw plate bearing three sharp, spiniform tooth papillæ, above which are teeth of similar shape; on either side are two spiniform mouth papillæ, whereof the outer one is longer and serves as a tentacle scale to the second mouth tentacle. The condition of the single specimen did not allow the forms of the mouth shields and side mouth shields to be made out, as they were pretty closely soldered and more or less covered with skin; they seemed, however, similar to those of *Ophiohelus umbella*. Under arm plates of a long axe-shape, much broader without than within, with a widely curved, outer edge, deep re-entering curves on lateral sides, and a small angle within. Side arm plates nearly meeting below, widely separated above, having a feeble spine ridge on their outer margin; before partly drying the specimen it is hard to make out their outline. No upper arm plates, so that the curious double arm bones show through the translucent skin (fig. 6). Disk, soft and delicate, slightly puffed, covered uniformly with scales so very thin that they can only be seen under the microscope by a cross light. No radial shields. Three nearly equal, sharp, somewhat flattened, arm spines, about as long as an arm joint and a half. When cleaned with potash they appear as two parallel spiculæ united by cross-bars (fig. 8). At the ninth joint there still are three spines standing near the outer margin of the side arm plate, but at a large angle to the arm, and just inside their base is a single minute parasol spine, or pedicellaria, about 0·6 mm. long (fig. 9); and stouter and with a larger head than in *Ophiohelus umbella*. On the joints beyond there are no longer any common spines, but, instead, two close rows of parasol spines, three or four in each row (fig. 7). Tentacles large, long, smooth and not provided with scales.

Colour in alcohol, translucent bluish-white.

Station 175.—August 12, 1874; near Fiji Islands; lat. 19° 2′ S., long. 177° 10′ E.; 1350 fathoms; red clay.

Species of *Ophiohelus* not herein described.

Ophiohelus umbella, Lym. (Pl. XXVIII. figs. 10–11).

Ophiohelus umbella, Lym., Anniv. Mem. Bost. Soc. Nat. Hist., pl. i. figs. 5–10 and 16, 1880.

Off Barbadoes; 82 fathoms.

Ophiotholia.

Ophiotholia, Lym., Anniv. Mem. Bost. Soc. Nat. Hist., 1880.

Disk and arms capable of being raised vertically: the former covered by a delicate scaling set with minute spines. Mouth angles clothed with several rows of wide, flat

mouth papillæ (as in *Ophiomyces*), and with a single row of slender, sharp teeth. On outer joints of arms, near margin of each side arm plate, is a tuft of minute, translucent, supplementary spines or pedicellariæ, which have the form of a long-handled parasol. They stand a little inside the true arm spines, which are continuous to the end of the arm.

Ophiotholia supplicans, Lym. (Pl. XXVIII. figs. 1–4).

Ophiotholia supplicans, Lym., Anniv. Mem. Bost. Soc. Nat. Hist., pl. i. figs. 1–9, 1880.

Three arm spines. Pedicellariæ beginning about the ninth joint and arranged in clusters of three or four.

Diameter of disk (when the arms are raised vertically) 2 mm. Height of same 3·5 mm. Width of arm without spines 0·8 mm. Length of arm about 13 mm. The mouth angles are high and narrow, so that the mouth slits between them are wide: with their curved sides and sharp tooth at the apex the angles bear a resemblance to a bird's head with a pointed bill. Three acute spine-like teeth, outside which, and partly encircling the large three-sided jaw plate, as with a frill, is a transverse, curved, erect, close row of eight or ten long, narrow, flat papillæ. Again outside these, and on the jaws and mouth frames are three parallel transverse rows of erect foliate papillæ. The first row has six papillæ, which are smaller than some of those beyond, but, like them, flattened and widest at the free end; the second row is similar; while the third usually consists only of two papillæ, much larger and wider than the others. These rows quite obscure the base of the mouth angle and mouth shields. In general, the arrangement is that of *Ophiomyces frutectosus*. The above numbers are the maximum; some angles have fewer papillæ; not more than four in a transverse row. In the fresh specimen, under arm plates are not visible, but, on partial drying, their outlines may be seen. They are narrow, much longer than wide, wider without than within, with a small angle within, lateral sides re-enteringly curved, and outer side in a broken curve. In like manner the side arm plates are seen to meet broadly below, and to form a slight spine crest at their outer edge. Figure 3 shows the arm joint from below, so covered by the natural skin that the junction of the side arm plates on the central ridge cannot be seen. Disk sugar-loaf shaped and sparsely set with minute spines, each of which, in the partly dried specimen, is seen to stand on a small, delicate scale. No radial shields visible, and there probably are none; which, as in *Ophiomyces*, may account for the fact that the arms are raised vertically, encircling the high disk like a fence. Three sharp, slightly flattened, microscopically rough arm spines nearly as long as a joint, standing near the outer edge of side arm plate, and on a low spine ridge. At the ninth joint there appears, on inner side of spine ridge, and close to base of spines, a cluster of three or four minute pedicellariæ, scarcely 0·5 mm. long. They are shaped like long-handled parasols, or slender-stalked agarics (fig. 4), with a long shaft,

surmounted by a disk divided into symmetrical radiating flutings, and with a slight bulb at the base articulated to a little mamelon. They are glassy and translucent, and naturally are enveloped in a skin bag which, however, is easily stripped off, leaving them free, as shown in the figures. They are found on all the outer joints, to the tip of arm. The tentacles are long, smooth, and translucent. The second mouth tentacle has four flat scales similar to mouth papillæ. The next two pairs have each two smaller scales, one on the side arm plate, the other on the under arm plate. Each pore beyond has one long, spine-like scale on its inner edge.

Station 296.—November 9, 1875; south-west of Juan Fernandez; lat. 38° 6′ S., long. 88° 2′ W.; 1825 fathoms; red clay.

Ophiomyces.

Ophiomyces, Lym., Bull. Mus. Comp. Zool., vol. i., part 10, 1869.

Teeth; no tooth papillæ; numerous wide, flat mouth papillæ, which are turned downwards and outwards, and arranged in two or more imbricated rows, covering the whole mouth angle. Side arm plates large, and meeting above. Disk finely scaled, without radial shields. Arm spines short and numerous (6–12), within the disk shorter, stouter, and of a different character from those of the joints further out.

This singular genus stands quite by itself, unless we compare its curious mouth papillæ with the spatula-like tentacle scales of *Ophiopsila*. All the specimens I have seen had a tendency to raise the arms above the disk, vertically; which shows that the muscular tension must have some peculiar proportion.

In the absence of radial shields, it differs from all others, and its general structure, without and within, shows additional peculiarities. The genital plate, thin, wide, and long (Pl. XLIV. fig. 7, *o*), curves over the top of the arm, and has a thin genital scale of similar character (fig. 6, *no*). The arm bones, within the disk, have large thin wings without marginal grooves. Their outer face is peculiar in having no articulating peg (fig. 8), though the inner face is furnished with a large umbo (fig. 9, 1). The jaws and mouth frames (fig. 7 *c*,*f*) are of an elegant shape, and curiously twisted. I did not observe any peristomial plate.

The Plate XLIV. figs. 6–9.

Ophiomyces spathifer, Lym. (Pl. XIX. figs. 10–12).

Ophiomyces spathifer, Lym., Bull. Mus. Comp. Zool., vol. vi., part 2, p. 47, pl. xiv. figs. 386–388ª, 1879.

Outer mouth papillæ large and paddle shaped. One flat, rounded tentacle scale. Ten flattened arm spines of various shapes, whereof the two lowest are borne on the under arm plate.

(Type specimen from Station 235.) Diameter of disk 3·5 mm. Width of arm next disk 1·2 mm. Three short, narrow, slightly flattened, peg-like teeth, carried on a thick, lumpy jaw plate, which also bears two long flat narrow, spatula-like tooth papillæ. On either side of the mouth angle are two radiating rows, each of about six long, flattened papillæ, which are imbricated and point downward and outward, so that the entire mouth angle is hidden by them; the inner ones are narrow and spatula-like, but outwards they grow rapidly larger, so that the outermost are wide paddle-shaped, or even fan shaped, their length to extreme breadth being ·7 : ·5. Mouth shields shaped like a long, sharp, narrow lance head. Side mouth shields three sided, delicate, separated as by a wedge by the mouth shield, which extends inward considerably beyond them. Within, and indistinctly separated from the side mouth shields project the long jaws. These parts are all hidden, and can be seen only by cutting away the mouth papillæ. Under arm plates small, with re-enteringly curved lateral sides, wider without, where they are a little swollen, than within, separated by the side arm plates, which meet narrowly both above and below, and are highest and most flaring at their outer edge. Upper arm plates minute (sometimes apparently wanting), twice as long as broad, and appearing like little swellings just outside the juncture of the side arm plates. The larger part of upper surface of arm is thus left uncovered, so that the arm bones and their muscular bundles may be seen. Disk (as usual in the genus) distorted and pushed upward, covered uniformly with minute, thin, translucent, flat scales, without spines; there are about 13 in the length of 1 mm. Ten arm spines, of which the three highest are equal, slender, narrow and tapering, and as long as any; the next two are of about the same length, but broad and flat, with rounded ends; the next three similar, but shorter; the two lowest spatula like, with ends cut square off, and carried, not on the side arm plate, but widely spaced on the outer part of the under arm plate; lengths to that of an arm joint, ·5, ·5, ·5, ·5, ·5, ·4, ·4, ·3, ·3, ·3 : ·5. One flat, short, wide tentacle scale, broader without than within, and, like many of the arm spines and mouth papillæ microscopically striated. Colour in alcohol, disk, grey; arms, straw.

Station 235.—June 4, 1875; lat. 34° 7′ N., long. 138° 0′ E.; 565 fathoms; mud.

Ophiomyces grandis (Pl. XIX. figs. 13–15).

Ophiomyces grandis, Lym., Bull. Mus. Comp. Zool., vol. vi., part 2, p. 46, pl. xiv. figs. 383–385, 1879.

Eleven sharp, flat arm spines, set along the whole upper and side edge of the plate, and growing longer from above down to the ninth. Basal under arm plates, large and squarish, and bearing three long spatula-like tentacle scales.

(Type specimen from off Tristan d'Acunha.) Diameter of disk 6·5 mm. Length of arm about 25 mm. Width of arm near disk 2·2 mm. Four or five broad, flat teeth with a curved, cutting edge; the lowest one being much the narrowest. Below these,

and still on the jaw plate, are three spiniform tooth papillæ. Then, from apex of mouth angle, there radiate, on each side, two rows of long flattened mouth papillæ, which completely hide the underlying parts; each row has five or six papillæ, of which the innermost one is spiniform, resembling a tooth papilla; those beyond, more or less spatula shaped, grow progressively larger and wider, until the outermost has almost a fan shape; all incline more or less downward and outward, so that they overlap, tile fashion. On cutting away the mouth papillæ, a small mouth shield, of an irregular, short diamond shape, may be seen, together with small triangular side mouth shields, which nearly meet within. Length of mouth shield to breadth, ·7 : ·7. The jaws are long, narrow, and slender, with very large sockets at their base for the second pair of mouth tentacles. The first under arm plate is minute, triangular, and difficult to distinguish; the second very narrow, closely soldered with surrounding parts, and with deep re-entering curves on the lateral sides; the fourth plate is four sided, about as broad as long, much wider without than within, and with deep re-entering curves on the lateral sides; length to breadth, ·6 : ·7. Side arm plates separated below, meeting narrowly above, not swollen, but clean cut and flaring outward. Upper arm plates twice and a half as broad as long, shaped like segments of a circle, with a clean curve outward; near tip of arm nearly as long as wide, and form a pointed curve, while the side arm plates are but slightly flaring and meet above on a line as long as the upper plate. The disk was much torn (as is usually the case,) but was evidently covered above and below with fine scales, about four in the length of 1 mm., whereof many bore minute, peg-like spines. Eleven arm spines, increasing rapidly in length from the first to the ninth, then diminishing; the upper ones are slender, sharp, and little flattened; the lower ones are broad, flat, sharp, and shaped like a bronze sword; lengths to that of an under arm plate, ·2, ·3, ·3, ·3, ·5, ·7, ·8, 1, 1·2, ·7, ·7 : ·7. The basal under arm plates, as far as the fifth or sixth, bear on each lateral side three long, flat, spatula-like tentacle scales, which project over the pore; for some distance beyond there are but two such scales, while a third, trowel-shaped, stands on the edge of the side arm plate. One-third out on the arm there remains only the large trowel-shaped scale. Colour in alcohol, pale grey.

Station, off Tristan d'Acunha; 1000 fathoms.

The peculiar twisting upward of the arms and disk of *Ophiomyces* is explained by the absence of radial shields, a want not yet observed in any other genus. It seems, then, that one function of radial shields is to keep the disk in shape, somewhat like the action of the sticks of an umbrella.

Species of *Ophiomyces* not herein described.

Ophiomyces mirabilis, Lym., Bull. Mus. Comp. Zool., vol. i., part 10, p. 343, 1869. Florida; 237 to 306 fathoms.

Ophiomyces frutectosus, Lym. (Pl. XLIV. figs. 6–9), Bull. Mus. Comp. Zool., vol. i., part 10, p. 345, 1869; Ill. Cat. Mus. Comp. Zool., No. vi., pl. ii. figs. 11–13; Bull. Mus. Comp. Zool., vol. v., part 9, p. 228.

West Indies; 77 to 160 fathoms.

Group III.—Astrophyton-like Ophiurans.

Ophiobyrsa.

Ophiobyrsa, Lym., Bull. Mus. Comp. Zool., vol. v., part 7, 1878.

Entire animal clothed in a thick skin, which hides the underlying plates, and is beset on the disk with spines. Arm nearly cylindrical. Side arm plates projecting as short flap-like spine ridges, which bear slightly rough spines on their outer edge. Tentacles large and simple. Few or no mouth papillæ, but at apex of mouth angle the teeth and tooth papillæ are represented by a clump of little spines. Two large genital openings in each interbrachial space.

On examining the under side of the disk skin, it will be seen that the short spines are the outgrowth of small plates which make a minute pavement (Pl. XLIII. fig. 16). These plates become much larger between the radial shields. The oblong radial shields (*l*) are small and short, and are attached to small, oval, solid, plastron-like genital plates (*o*) which cling close to the arm and almost meet on its upper median line. Near the outer end is jointed the short, curved and rather slender genital scale (*n*), which extends farther inward than the plate. The general external resemblance to *Ophiomyxa* is carried out in the arm plates, whereof the under one is shield-shaped with an angle inward and re-entering curves where the tentacles come out. To it are attached side arm plates shaped somewhat like a shoe sole, and these are continued upward by small round pieces which correspond to upper arm plates. The arm bones, however, are perhaps nearest those of *Sigsbeia*. They are discoid, with plain, not very thick edges. Their outer face looks like a feeble essay at the arm bone of an *Astrophyton*. There is the large articulating shoulder (fig. 17, 4), below which is an irregular vertical groove which passes through the place of the absent articulating peg, and is fitted to receive the umbo (fig. 18, 1), which is continued downward by a pillar-like prolongation. The small mouth angle is quite covered above, to the inner edge of the nerve ring, by the thick, swollen, single peristomial plate (*v*), which is closely soldered to the surrounding parts, and is so large as nearly to connect with its neighbours. The small jaw (*c*) carries a little bead-like tooth (*e*).

See Plate XLIII. figs. 16–18.

Ophiobyrsa rudis, Lym. (Pl. XVI. figs. 18–20; Pl. XLIII. figs. 16–18).

Ophiobyrsa rudis, Lym., Bull. Mus. Comp. Zool., vol. v., part 7, p. 131, pl. viii. figs. 198–200, 1878.

Disk closely covered with short spines. Arms very long, tapering, and nearly cylindrical. Six short arm spines.

(Type specimen from Station 161.) Diameter of disk 28 mm. Length of arm 300 mm. Width of arm without spines 3·5 mm. One small, short, delicately pointed mouth papilla on each side of the mouth angle, and at the apex a clump of short, sharp, spine-like papillæ, which occupy the place of teeth. Mouth shields obscured by thick skin; only their rounded outline may be distinguished. Side mouth shields and upper arm plates entirely concealed by thick skin. Side arm plates project to form a thin, short, flap-like spine ridge. On the upper surface of the arm there are two longitudinal rows of very short, stout spines arranged in pairs, and usually standing on tubercles. Disk five-sided and rather thin, covered by a thick skin, which is closely and evenly beset above and below with short, stout, smooth, sharp spines or thorns; they are somewhat longer and more numerous near the margin of the interbrachial spaces, and are almost wanting just over the base of each arm. Six equal, short, blunt, flat, somewhat rough arm spines, partly covered by skin, not so long as an arm joint, and placed on the edge of side arm plate. Tentacles large, simple, and round. No tentacles scales. Colour in alcohol, disk, yellowish-brown; arms the same, but much lighter.

Station 161.—April 1, 1874; off entrance to Port Philip; 38 fathoms; sand.

Ophiomyxa.

Ophiomyxa, Müll. & Tr., Syst. Ast., 1842.

Disk and arms wholly covered with a thick, naked skin. No tooth papillæ. Mouth papillæ and teeth in the form of flattened lobes, with saw-like cutting edges. Arm spines stout, bulging at the base, thorny at the point, covered round the base with thick skin; near the tip of the arm, the lower arm spine has hooks along its edge. Arms rounded; arm plates imperfectly developed. No tentacle scales. Two genital openings, beginning outside the mouth shield.

A thick naked skin envelops the arms and disk where it is strengthened by a line of marginal, overlapping scales; minute scales are also more or less scattered on its under surface. The small, irregular radial shields rest their inner end on a clump of scales, after the fashion of *Ophiocoma*. Their outer end is articulated to a long, stout, rounded genital plate,[1] to whose side, at a point far inward, is attached a short genital scale, the two together making a figure somewhat like a lobster claw. A row of stout scales unites the mouth shield to the genital plate. The arm bones have a rather long flat top with a

[1] See Bull. Mus. Comp. Zool., vol. iii., part 10, pl. vi. fig. 18.

shallow median canal. Their outer surface has a large, round mamelon (an exaggeration of the articulating shoulder) having above a central gulley to admit the umbo of the next bone; and below a minute articulating peg with a small depression on either side to admit the knobs of the succeeding bone. The whole is not unlike *Ophiochondrus* (Pl. XLIII. figs. 12, 13), and shows a leaning towards the Astrophytidæ. By doing away on the outer face with the articulating peg, and deepening the central gulley, we get a shape like *Sigsbeia*, and by flattening the tentacle sockets in this last we arrive at the proper transverse hour-glass projection.

Taking then the inner face, and widening the umbo above (fig. 13, 1) and the knobs below (2), there results a form like that of *Sigsbeia* (fig. 6), and by further enlarging this figure and diminishing the muscle fields, there is produced a true vertical hour-glass projection (compare Pl. XXV. figs. 24, 25). In a word, the Astrophytons, with their slender arms, rolling in a vertical plane, and furnished with small tentacles, have simple hour-glass joints, muscle fields little and flat, and small tentacle sockets.

The short mouth angle of *Ophiomyxa* is covered quite to the inner edge of the nerve ring by a pair of stout, triangular peristomial plates. A further *Astrophyton*-like feature is the arrangement of the arm plates, whereof the under one is small (Pl. XLIII. fig. 2), and sometimes even in three pieces (*Ophiomyxa pentagona*), and has attached to it a massive side arm plate (figs. 1 and 3, *i*), of which the greater portion is on the under side of the arm, bearing stumpy, thorny spines (*p*), and continued upward by a number of thin pieces homologous with upper arm plates (*j*). In *Ophiomyxa vivipara*, however, there are no upper arm plates, a want which brings the species near *Ophioscolex*.

See Plate XLIII. figs. 1–3.

Table of Species of *Ophiomyxa*.

Although *Ophiomyxa* has only four species, a table of them is given, because they are distinguished chiefly by internal characters.

Radial shields short and thick. Marginal disk scales small and thin. Under arm plates in three pieces. Upper arm plates in two pieces. Disk skin with small thin lime plates, ...	*Ophiomyxa pentagona.*
Radial shields long and rounded. Marginal disk scales large, thick, few. Under arm plates wider than long with an outer notch. Upper arm plates in several pieces on each side. Disk skin thick, with small scattered lime nodules, .	*Ophiomyxa flaccida.*
Radial shields short and wide. Marginal disk scales small, numerous, regular. Under arm plates as long as wide with an outer notch. Upper arm plates in several pieces, and connected along ridge of arm by other pieces. Disk skin thin and naked, ...	*Ophiomyxa australis.*
Radial shields short, wide, flat. Marginal disk scales small and narrow. No upper arm plates. Under arm plates hexagonal with re-entering curves. Disk skin beset with calcareous plates, ...	*Ophiomyxa vivipara.*

Ophiomyxa flaccida, Ltk. (Pl. XLIII. figs. 1–3); Addit. ad Hist., part 2, p. 138, pl. v. fig. 1, 1859; Lym., Ill. Cat. Mus. Comp. Zool., No. i. p. 178, pl. ii. figs. 18–19; Vll. Trans. Conn. Acad., vol. i., part 2, p. 366; Lym., Bull. Mus. Comp. Zool., vol. v., part 9, p. 233.

Ophiura flaccida, Say, Journ. Phil. Acad., vol. v. p. 151, 1825.
Ophiomyxa caribœa, Ltk., Vid. Meddel., p. 10, 1856.

Bahia; 7 to 20 fathoms.

Station 36.—April 23, 1873; off Bermudas; 32 fathoms; mud.

Ophiomyxa australis, Ltk., Addit. ad Hist., part 3, p. 99, 1869.

Station 161.—April 1, 1874; off Entrance to Port Philip; 38 fathoms; sand. St. Paul's Rocks; 100 fathoms. Station 162.—April 2, 1874; off East Moncœur Island, Bass Strait; 38 to 40 fathoms; sand. Station 163.—April 4, 1874; off Twofold Bay; lat. 36° 56′ S., long. 150° 30′ E.; 120 fathoms. Station 172.—July 22, 1874; off Nukualofa, Tongatabu; 18 to 240 fathoms; coral. Station 173.—July 24, 1874; lat. 19° 10′ S., long. 179° 40′ E.; 310 to 315 fathoms; coral. Station 167.—June 24, 1874; lat. 39° 32′ S., long. 171° 48′ E.; 150 fathoms; grey ooze. Station 201.—October 26, 1874; lat. 7° 3′ N., long. 121° 48′ E.; 82 to 102 fathoms. Amboyna; 100 fathoms; stones and gravel.

Ophiomyxa vivipara, Studer, Monatsb. d. König. Akad. Berlin, p. 462, 1876; Cape of Good Hope, Kerguelen Island, Straits of Magellan.

Studer (*loc. cit.*) describes the arrangement of the embryos within the mother. I found them quite as described by him.

Station 142.—December 18, 1873; lat. 35° 4′ S., long. 18° 37′ E.; 150 fathoms; sand. Station 308.—January 5, 1876; lat. 50° 10′ S., long. 74° 42′ W.; 175 fathoms; mud. Station 313.—January 20, 1876; lat. 52° 20′ S., long. 68° 0′ W.; 55 fathoms; sand. Station 314.—January 21, 1876; lat. 51° 36′ S., long. 65° 40′ W.; 70 fathoms; sand.

Species of *Ophiomyxa* not herein described.

Ophiomyxa pentagona, Müll. & Tr., Syst. Ast., p. 108, 1842; Lym., Ill. Cat. Mus. Comp. Zool., No. i. p. 180; Bull. Mus. Comp. Zool., vol. iii., part 10, p. 272, pl. vii. fig. 18; Ludwig, Anatomie der Ophiuren, Zeits. für Wissen. Zoologie, vol. xxxi. p. 241; Echin. des Mittelmeeres, p. 352.

Stella pentagona scolopendroides regularis, Linck, De Stell. Mar., p. 51, pl. xxvii. fig. 46, 1733.
Ophiura pentagona, Lmk., Hist. Anim. sans Vert., vol. ii. p. 546, 1816.

Mediterranean, Adriatic, and Ægean Seas.

Ophiochondrus.

Ophiochondrus, Lym., Bull. Mus. Comp. Zool., vol. i., part 10, 1869.

Teeth. Mouth papillæ, which are about seven and are short and crowded. No tooth papillæ. Disk granulated; contracted, so that the interbrachial spaces are re-enteringly curved, and are further reduced by the encroachment of the stout arms, which roll in a vertical plane. Four to six small, smooth arm spines. Side mouth shields meeting within. Side arm plates meeting below, and there closely soldered. Two genital openings in each interbrachial space.

One is surprised to find so powerful a frame in animals whose exterior seems scarcely to indicate peculiar strength. The thick disk skin, granulated above, is set below with stout, irregular plates, and supported by long, thick, bar-like, solid radial shields (Pl. XLIII. fig. 11, *l*). To these are articulated massive, shapeless, genital plates (*o*), a full half of whose length is occupied by the clubbed head, while the comparatively small shaft is rounded and tapering. About half-way of its length there is soldered to it a small, rounded genital scale (*n*). Not less thick and strong are the large transverse oval peristomial plates (*v*), which, usually single, but sometimes divided in two, nearly touch each other by their proximal corners. Within the disk the arm bones are plain and discoid; but beyond the margin they take on a curious elongated shape (*w'*). Their outer face has a wide massive articulating shoulder (fig. 12, 4) to support the large umbo of the next bone (fig. 13, 1) the articulating peg (6) is small and has no distinct hole for its reception in the next bone. From above, the bone (fig. 15) is seen to be massive, widest within, and with a well-marked median canal (*t'*); from below (fig. 14), it has a similar outline, with a very deep canal (*t*) having rolling margins, large, deeply excavated muscle fields (*w*), and small tentacle sockets (*r*) quite at the outer end. The great length of these arm bones gives them an embryonic character, found also in *Ophiomusium*. The inner face shows a slight leaning towards *Astrophyton*, but on the whole they are truly Ophiuran in structure.

Ophiochondrus stelliger, Lym. (Pl. XXI. figs. 13–15); Bull. Mus. Comp. Zool., vol. vi., part 2, p. 44, pl. xiii. figs. 371–373, 1879.

Disk finely and evenly granulated on both sides. Four slender arm spines, whereof the uppermost is much the longest.

(Type specimen from Station 320.) Diameter of disk 5 mm. Length of arm 16 mm. Width of arm near disk 1·3 mm. Three mouth papillæ on each side, whereof the two outer are flattened and squarish, while the innermost is stout, rounded, tapering, and peg-like. Apex of mouth angle occupied by the lowest tooth, which is sometimes represented by two blunt, spiniform papillæ similar to their next neighbour. Four rather narrow

teeth, which are sometimes almost spiniform, but usually flattened. Mouth shields much wider than long, with a well marked obtuse angle inward and the outer side gently curved; length to breadth, ·7 : 1·1. Side mouth shields long, rather narrow, of nearly equal width, slightly curved, and fully meeting within. First under arm plate small, longer than broad, hexagonal, with rounded corners; the plates beyond are rather small, wider than long, bounded without by a broad curve, and within by an obtuse angle; the lateral sides are very short, or are confounded in the outer curve. Side arm plates small, somewhat wider than long, fan shaped, with inner angle rounded. Disk rather thick, finely and uniformly granulated above and below, about seventeen grains in the length of 1 mm. Four cylindrical, tapering, rather slender arm spines, whereof the uppermost is longest: lengths to that of an arm joint, 1·1, ·6, ·5, ·4 : ·6. One small, narrow tentacle scale. Colour in alcohol, straw.

Station 320.—February 14, 1876; lat. 37° 17′ S., long. 53° 52′ W.; 600 fathoms; hard ground.

Species of *Ophiochondrus* not herein described.

Ophiochondrus convolutus, Lym. (Pl. XLIII. figs. 11–15).

Ophiochondrus convolutus, Lym., Bull. Mus. Comp. Zool., vol. i., part 10, p. 328, 1869; Il. Cat. Mus. Comp. Zool., No. vi., pl. ii., fig. 7; Bull. Mus. Comp Zool., vol. v., part 9, p. 223.

West Indies; 175 to 292 fathoms.

Hemieuryale.

Hemieuryale, V. Mart., Monatsb. König. Akad. Berlin, 1867.

Teeth. Numerous small crowded mouth papillæ. No tooth papillæ. Disk small and covered with scales and large swollen radial shields. Arms long, and rolling in a vertical plane, furnished with under and side arm plates of the ordinary form, but covered above by a mosaic of small, swollen plates, whereof one, much larger and higher than the rest, is on each side of the arm. Two short genital openings in each interbrachial space.

Here is another solid structure comparable to *Ophiochondrus*. The great radial shields with their thickened margins occupy almost the entire upper disk (Pl. XLIII. fig. 7). To each is jointed a massive, shapeless genital plate (*o*) extending quite to the mouth shield, and which has soldered to it a small genital scale (*n*). The mouth angles are compact, and the mouth frames (*f*) scarcely flaring over the nerve ring is a small, single, rounded peristomial plate (*v*). Beyond the disk the arm bones are elongated, much as in *Ophiochondrus* (fig. 10), and, in profile, exhibit an umbo (*i*) projecting from the hinder end, and a still larger articulating shoulder from the outer end; while below are large

muscle fields (*w*) and tentacle sockets (*r*). The outer face of the bone is one step nearer *Astrophyton* than *Ophiochondrus*, having a large articulating shoulder (fig. 8, 4) without any articulating peg below. The inner face (fig. 9) shows the simplest form of the Ophiuran joint, and is largely occupied by the great umbo (1). In general, the position of this highly interesting genus was correctly laid down by me in 1872.[1] The original discoverer, Von Martens,[2] was, however, right in thinking it had a relationship, albeit a faint one, with the Astrophytidæ.

See Plate XLIII. figs. 7–10.

Species of *Hemieuryale* not herein described.

Hemieuryale pustulata, V. Mart. (Pl. XLIII. figs. 7–10).

Hemieuryale pustulata, Monatsb. König. Akad. Berlin, p. 484, 1867; Ljn., Dr. Goës, Oph. Öf. Kong. Akad., p. 617; Lym., Ann. Sci. Nat., vol. xvi., art. 4, p. 5; Bull. Mus. Comp. Zool., vol. iii., part 10, p. 268, pl. v. figs. 8–11.

Ophiura cuspidifera (?), Lmk., Hist. Anim. sans Vert., vol. iii. p. 226, 2nd ed., 1840; Encycloped. Meth., pl. cxxii. figs. 5–8.

West Indies; 74 to 180 fathoms; Senegal (?).

Sigsbeia.

Sigsbeia, Lym., Bull. Mus. Comp. Zool., vol. v., part 9, 1878.

Disk small, covered with very large radial shields and heavy plates or scales, and passing, without line of demarcation, into the stout arms, which can be rolled in a vertical plane. Teeth and small close-set mouth papillæ; no tooth papillæ. Arms bearing the usual plates, and in addition a large supplementary piece extending downward from the upper arm plate. Two very small genital openings in each interbrachial space, near the mouth shield.

This singular genus forms a peculiar group with *Hemieuryale*, from which it is distinguished by having ordinary upper arm plates, instead of a mosaic of small pieces.

It represents the maximum of lime deposit, both without and within. Nothing can be more unexpected than the ease with which the animal rolls up its arms incased as they are in thick, clumsy armour, and having an axis of massive arm bones. The radial shields are of great size and thickness, so that they cover nearly the whole upper disk and form a connected circle (Pl. XLIII. fig. 4, *l*). Attached to each is a short, wide, thick, swollen, irregularly wedge-shaped genital plate (*o*), with a thick, narrow,

[1] Ann. Sci. Nat., vol. xvi. art. 4, p. 5.

[2] Monatsb. König. Akad. Berlin, p. 484, 1867.

shapeless genital scale soldered for most of its length, and only leaving a small genital opening near the mouth shield. Sometimes the genital scale is soldered with its neighbouring scale in one, and sometimes it nearly or quite disappears, leaving the interbrachial space almost wholly filled by the two genital plates. The outer face of the arm bone (fig. 5) makes a near approach to that of *Astrophyton*, having the articulating shoulder (4) nearly of the transverse hour-glass form: the great muscle fields and large tentacle sockets (*r*) are, however, distinctly Ophiuran. The inner face also (fig. 6) has a similar mixed character, with its large umbo (1) prolonged downwards, and forming a vertical hour-glass. The mouth frames (fig. 4, *f*) are massive and plain, without grooves or ridges, and the peristomial plate (*v*) is small, single, rounded and intimately connected with the surrounding parts. The resemblance of the arm bone joints to those of the Astrophytidæ is striking; but is not carried to other parts of the structure, which is truly Ophiuran, although the loading of the tissues with so much lime gives it a character of its own.

See Plate XLIII. figs. 4–6.

Species of *Sigsbeia* not herein described.

Sigsbeia murrhina, Lym. (Pl. XLIII. figs. 4–6).

Sigsbeia murrhina, Lym., Bull. Mus. Comp. Zool., vol. v., part 9, p. 234, pl. iii. figs. 55–58, 1878.

West Indies; 88 to 422 fathoms.

Astrophytidæ.

Astrophytidæ are a family in the order of starfishes characterised by a more or less sharply defined central disk containing a digestive cavity, simple or much pleated, which has no anal opening, and does not pass into the arms. These, sometimes simple and sometimes ramified, have a central axis composed of jointed, vertebra-like sections (arm bones), each made up of two ambulacral pieces soldered side by side. Their joints consist of a horizontal and a vertical hour-glass-like projection fitted one on the other. The axis is covered by a thick skin, under which are plates, generally of an irregular and elementary character; and there are no spines on the sides of the arms. Each arm bone is pierced by a water tube, destitute of a bulb, and supplying the imperforate tentacle, which is imbedded in the bone itself. The halves of the first two arm bones are swung laterally into the interbrachial space and soldered together to form the mouth angle; and in them are set the mouth tentacle which are watered by a forking tube from the mouth ring. On either side of the base of each arm, above and below, run two stout pieces, the radial shield and genital plate, which are joined at the margin of the disk, and are connected by an adductor muscle. In the lower interbrachial space, close to and parallel with each

arm, is a genital opening which, in most of the simple armed species, passes into a sac or genital bursa; but, in the ramifying species, enters directly the main body cavity. Most of the simple armed have a mouth shield at the inner angle of each lower interbrachial space, one of which serves as the madreporic. But, the ramifying have often no mouth shields at all, and the madreporic plates, sometimes one and sometimes five in number, are found in various regions of the lower interbrachial spaces.

Astrophyton.

Astrophyton, Linck, De Stell. Mar., 1733.

Disk re-enteringly curved in the interbrachial spaces, and, together, with arms covered by thick skin. Arms extremely wide at their base, so as to occupy a large part of the disk, and branching by a series of numerous forks having between them short, and nearly equal shafts. Radial shields long and bar-like, composed of overlapping soldered plates, and extending nearly or quite to centre of disk, thus forming more or less elevated radiating ribs. A portion of interbrachial space below strengthened by numerous plates. Teeth, tooth papillæ, and mouth papillæ, all similar and spiniform. No arm spines, but the outer branches have spiniform tentacle scales, which, as well as tentacles, are wanting on the basal joints. The finer twigs only are ringed with double lines of grains bearing microscopic hooks. Under side of arm entirely covered by side arm plates. No under arm plates beyond the first; and no upper arm plates at all. Two short genital openings at the outer corners of each interbrachial space.

In order to give a comparative idea of the genera *Astrophyton*, *Gorgonocephalus*, and *Euryale*, there will be furnished some details of their skeletons.

The radial shields of *Astrophyton* (Pl. XXXV. fig. 18, *l*) are composed of soldered overlapping plates, as in *Gorgonocephalus*, but differ in being higher and less diverging. For the bracing of the broad, heavy arm there is on either side a massive, rounded genital plate, shaped like an elongated cone (*o*). Its strength recalls the same part in *Euryale*, as does the rudimentary genital scale (*n*) near its outer end. The distribution of irregular plates under the disk skin is the reverse of that in *Gorgonocephalus*, which has a compound row just along the margin, whereas in the present genus the plates, which are large and flat, fill the inner angle of the lower interbrachial space (figs. 17, 18), which thus becomes a structure more calculated to give a strong leverage to the arm. The mouth frames and jaws, broad, flattened and closely joined below (fig. 17, *c*), become much narrower above (fig. 18, *c*), where there is a swollen, oblong peristomial plate (*v*) of one piece. Their shape and massiveness recall *Euryale* (fig. 1, *c*), but the bunch of spiniform tooth papillæ is similar to that of *Gorgonocephalus;* to which also *Astrophyton* is comparable as to its small and irregular side mouth shields (fig. 17, *b*), while those of *Euryale* are of great size and thickness and nearly symmetrical (fig. 1, *b*).

Seen in profile from its brachial side, a mouth angle has the look of a wedge-shaped block, having, however, a correspondence with the same part among Ophiurans. Outside is the furrowed articulation of the mouth frame to its fellow (fig 23, *x*). Then comes, on the upper surface, the peristomial plate (*v*), followed by the jaw (*c*), and the jaw plate (*e*) divided into nodules. On the sides are the great cavities for the first and second mouth tentacles *r'*, *r''*, which have notches in their outer margins for the passage doubtless of their nerves. Just inside the articulating surface (*x*) are two curved, nearly vertical furrows, whereof the innermost must be for the radial nerve, and the outermost for the radial water tube. Among the terminal arm twigs, the structure of side arm plates, hook grains and tentacle hooks is essentially that of *Gorgonocephalus* (figs. 19, 20, 22); farther inward, however, all hooks, whether on grains or on side arm plates, disappear, a fine granulation covers the arm (fig. 21), and even the tentacle pores themselves are obliterated inside the second fork (fig. 17). From both other genera, the present is distinguished by a total absence of under arm plates, unless the little plate at the outer corner of the mouth slit may be called one (fig. 17, *h*). On the other hand the side arm plates are strongly developed although confined, as usual, to the under surface and lower sides of the arm. Near the tip they have the usual shape (fig. 20, *i*); but near the base they take on the form of wide flat plates, meeting on the median line, and having small re-entering curves on their inner and outer edges, whereby little vacant ovals are left which look like very large tentacle pores (fig. 17, *i*). Already on the smaller twigs the tentacle hooks on the side arm plates (fig. 22, *q*) have changed from a curved and sharp outline (fig. 20, *q*) to a blunt spine-like form; and soon after, they drop off; a fine granulation covers the arm, and within half a dozen forks of the tip, nothing appears of the side arm plate but a small mamelon with a tentacle hole (fig. 21, *i*). An examination of the under side of an arm bone shows that the tentacles do not, as Gaudry supposed, lie between the bones, but on the front under surface (fig. 26, *r*) quite as among Ophiurans. At the bottom of the tentacle socket is a pore for the water tube which should first pass into the hole above and nearer the centre, and so curve upward through the substance of the bone, to descend again to the tentacle socket.

The numerous specimens of *Gorgonocephalus*, and their different sizes furnish material for a sketch of the growth of the hard parts. The young, with a disk 2·5 mm. in diameter (Pl. XXXVI. figs. 2, 3), is covered with a skin which, when dry, exhibits distinctly the underlying plates somewhat like those of *Ophiolepis*. The jaw (*c*) with its teeth (*d'*) are joined to two large side mouth shields. From this point of view no jaw plate can be seen till the animal is larger (fig. 17, *e*). Outside the side mouth shields is a plate which holds the position of a mouth shield, and sometimes takes the function of a madreporic plate (fig. 17, *a*). The remainder of the lower interbrachial space is covered by eight or nine irregular plates. Above, there is in the centre a group of six or seven primary plates (fig. 3, *g*), each encircled by a superimposed line of grains.

No distinct radial shields are yet visible; but along the margin of the disk are overlapping plates, which, increased in number and size, may be found under the skin of the adult. A ring, consisting of two large side arm plates (occupying the under surface) and four pieces representing upper arm plates, surrounds the arm (fig. 2). Fig. 1 gives a lower view of the entire animal of figs. 2 and 3 before drying. All the lower plates are concealed by the thick skin, although the upper ones may be distinguished. There are, as yet, but two arm forks, and the first one is far from the disk, as in *Trichaster*. There is one madreporic plate in the usual position of a mouth shield. It looks like a little pimple, but has been omitted by the lithographer. Tentacle scales, like little hooks, are found as far as the joint where the arm joins the disk. By the time the disk has attained a diameter of 7 mm. considerable changes have taken place. The granulations, which had only appeared as lines in the younger stage, now almost wholly hide the plates, both above and below (fig. 17). The genital plates and scales (*o*,*n*) not noticed before are now prominent. The madreporic shield (*a*) is swollen and perforated; and the jaw has a well-marked jaw plate, and on the sides mouth papillæ. In a fully grown specimen traces of the young stage may still be followed. On removing the skin from the mouth angles of a disk 60 mm. in diameter (fig. 19) there appear a jaw and jaw plate (*c*,*e*) more rounded and less elongated than in the young. Outside these, but of comparatively small size, are the side mouth shields (*b*), and, again outside these, the madreporic shield (*a*). The copious granulation, which, during the middle stage, covered the lower interbrachial space (fig 17) has essentially disappeared, as have the disk plates, which ceased to grow and were obliterated in the thick skin. Above, the disk shows no granulation (*Gorgonocephalus agassizii*) save in form of a few small spines whose bases are surrounded by grains; just at the margin may be recognised the lines of plates already referred to. The chief features of the roof of the disk are the high and long radial shields, so characteristic of the group.

Thus, a disk, flat at the beginning and covered with plates quite as among ordinary Ophiurans, proceeds to change, first by covering itself with a close granulation; secondly, by the disappearance or atrophy not only of this granulation but of the disk plates, except those of the margin which continue to grow and multiply; thirdly, by the great development in length and height of the radial shields.

The beginning of an arm, as illustrated at its tip, differs in no essential from that of Ophiurans.[1] A small swelling or knob makes the end, and indicates the beginning of the next new joint (figs. 4, 5). The penultimate joint is divided lengthwise, above and below, making the side arm plates (*i*) which enclose the arm. From the outer edge of these plates springs a slender projection of lime spicules which, by a constriction near its base, becomes a small jointed spine. This bends at its point, throws out an additional curved branch, and becomes a double tentacle hook (fig. 14), homologous with those in *Ophiothrix* and

[1] Bull. Mus. Comp. Zool., vol. iii., part 10, pl. v. figs. 2, 8, 12.

many other genera. There are usually three to each side arm plate, and they grow thicker as they near the base of the arm, where they acquire the form of little, blunt, rough spines (figs. 10, 11, 12, *q*). Besides double tentacle hooks, there are others that are simple, and, from the grain on which they are mounted as a base, may be termed grain hooks. Those that first appear are simple spicules, bent or straight, standing on the side arm plates, above the tentacle hooks (figs. 8, 9). Then a granule is formed under them (fig. 13). More of such hooks grow on the grains or little swollen plates which occupy the position of upper arm plates among Ophiurans (fig. 10). Later there remain on the side arm plate only the true tentacle hooks, while the grain hooks stand on those double rows of raised grains which give the ringed or burred look to the small branches of Astrophytons (Pl. XXXV. fig. 19). As they approach the disk and thicker part of the arm these raised rows sink and their hooks disappear, and a coarse granulation overgrows the first layer of swelled plates, so that the surface of the arm becomes even. The side arm plates which began as ridges encircling the whole arm change their character rapidly. In the central depression between them, on the upper side of arm, a little upper arm plate begins to form (Pl. XXXVI. fig. 5), like a perforated lime crust. Then, as the arm enlarges, the side plates separate above, and between them are formed additional scales, which occupy the position of upper arm plates, but follow no rule in their growth (fig. 7). They do not even multiply by the irregular method of *Hemieuryale pustulata*.[1] These scales, at first thin (figs. 7, 15), afterwards thicken and become more rounded (figs. 10, 11), and some of them make the basis of the two annular rings of grains carrying the grain hooks, which afterwards drop off, so that at the base of an arm there appear (in a dry specimen) only the thickened skin, with a granular coat and a few irregular plates above the side arm plates. These last, early separated above (figs. 7, 15), maintain their union underneath (figs. 6, 12, 16, 17, 19, *i*). It follows that the growing arm rises more and more above them. They retain their simple form almost throughout, but, within the disk, in fully grown specimens they are broken in two (fig. 19, *i*). The under arm plates first appear about two forks from the tip of the arm; not, however, simple, but divided in three parts (fig. 12, *h*), which may still be seen inside the disk of young specimens (fig. 17, *h*, *h*).[2] In adults these plates, at the third fork of the arm, are in four triangular pieces, making together an oblong figure. Within the disk the number of pieces is considerable and their form irregular (fig. 19). In this respect there is a marked difference from Ophiurans, whose upper arm plates may be composed of several pieces developed under certain rules, but whose side and under plates are almost always simple, rarely of two pieces, and in one species only (*Ophiomyxa pentagona*) of three pieces.

[1] Bull. Mus. Comp. Zool., vol. iii., part 10, pl. v. figs. 8–11.

[2] Lutken's figures indicate that the young of *Gorgonocephalus eucnemis* has the under arm plate not divided (Addit. ad Hist. Oph., vol. i., pl. ii. figs. 17*b* and 17*b'*).

The skeleton of a *Gorgonocephalus* does not differ more from that of an ordinary Ophiuran than those of Ophiurans differ among themselves. All the mouth parts are present (figs. 18, 19); mouth frames (*f*), jaws (*c*), jaw plate (*e*), sockets for two sets of tentacles (*r*,*r'*), and a large peristomial plate (*v*) in two pieces. There is, in addition, a small angle cover (*v'*), which is strongly developed in most Astrophytons, and which Ludwig considers the first under arm plate. The radial shield, genital plate (*o*), and genital scale (fig. 17, *n*) occupy normal positions. In regard to the radial shields, this peculiarity is to be remarked, that they are made up of a series of plates soldered one on the other like tiles. This structure calls attention to the fact that radial shields, which, from their almost constant presence, and their articulation with the genital plate, are usually considered exceptional parts, are truly nothing more than a disk scale, or a series of soldered disk scales. Hinged to the genital plates they regulate the position of the roof of the disk as it is raised or lowered. Moreover, the genital plates themselves, with their genital scales, are nothing more than highly specialised scales of the lower interbrachial space, folded in, and bounding the genital openings on either side. In some genera (*e.g.*, *Ophiomusium*) the genital plate is externally conspicuous as one of the chief pieces of the lower interbrachial space. The arm bones do not essentially differ from those of Ophiurans, except that their joints are simplified so as to be adapted to rolling in a vertical plane. The outer face has the usual transverse hour-glass projection, which is vertical on the inner face.

Passing now to *Euryale*, striking variations present themselves. The proportions and arrangement of the mouth differ much from those of *Gorgonocephalus*. Two large, flattened jaws (Pl. XXXV. fig. 1, *c*) support a small jaw plate (*e*), which carries, not the usual bunch of spines, but a vertical row of flat teeth (*d''*) like those of Ophiurans, or those of *Astroschema*. Seen from above, the jaws (*c*) and mouth frames (*f*) are much more solid than in *Gorgonocephalus*, and the peristomial plate (*v*), instead of being flat and divided, is much swollen and single. While *Gorgonocephalus* has the under arm plates in three pieces at the tip of the arm, and existing at its base only as irregular, broken scales, *Euryale* has them nearly or quite unbroken (figs. 1, 6, *h*) and of a regular form for the whole length of the arm except the terminal twigs. It is at the end of the arm that there is a remarkable difference in the side plates of the two genera. *Gorgonocephalus* has small thick plates clinging close to the arm, while *Euryale* is furnished with long, finger-like projections standing free and bearing prehensile hooks (figs. 8–12).

A side arm plate of the same general character may be found at the tip of the arm of *Ophiothrix pusilla*.[1] Passing towards the disk, these plates grow shorter and wider, and their hooks thicken into club spines (figs. 8, 9, *i*,*g*). Still further inward the side plates are nearly like those of Ophiurans, and carry little conical tentacle scales (or arm spines) on

[1] Bull. Mus. Comp. Zool., vol. iii. p. 10, pl. iii. fig. 28.

their outer edge (fig. 6, *i,g*). There are no proper upper arm plates, but (as in *Gorgonocephalus, Astroschema*, and *Ophiomyxa*) the vault of the arm is strengthened and partly covered by grains, or small plates, lying under the skin. Near the base of the arm they are arranged in a double vertical row (fig. 4, 5, *j*) ending on the upper median line in a stout piece (*j'*), the base, on which is mounted the peculiar spine of this species (*z*). The vertical exterior double rows of hook-bearing grains, found in *Astrophyton, Gorgonocephalus, Astroclon, Astrocnida, Astroporpa, Astrogomphus, Astrochele*, and *Astrotoma* do not exist at all in this genus, which agrees in this respect with *Trichaster, Astroceras, Astroschema, Ophiocreas*, and *Astronyx*. The chief bracing pieces, namely, radial shield and genital plate, are stout and firmly hinged, and the former (fig. 3, *l*), instead of being composed of united overlapping scales, is solid; while the latter (*o*) is firmly bedded in a series of soldered plates, which connect it with the side arm plates (*i*). Attached to the articulation is a short, very stout, genital scale (*n*). The arm bones are lower and wider than among kindred genera, but are jointed in the usual way; that is to say, the inner face presents a vertical prominence constricted in the middle (fig. 14, β), while the outer face has a similar but horizontal prominence (fig. 13, *y*), and the two, held together by muscles and skin, make a free-playing joint. At each forking of the arm a curious modification takes place. The bone, while retaining its general form, is much widened and is split vertically almost in two (fig. 16); on the inner face of each half is a vertical hour-glass prominence (β), and the outer face of the arm bone next within is suitably modified (fig. 15) by being much widened, and by having, at its constricted part, an articulating peg, or wedge, which fits into the hollow between the two vertical hour-glasses just described. At the joint outside these, the forking is perfect, and each prong has an arm bone of nearly the normal shape.

Table of Species of *Astrophyton*.

Only one madreporic shield at inner angle of an interbrachial space.	Disk with very high radial shields bearing a few stout stumps, covered with thick skin, and often fluted,	*Astrophyton costosum.*
	No tentacle scales on pores. Disk and arms quite smooth, the latter with faint belts of hooklets,	*Astrophyton nudum.*
	Radial shields closely beset with small thorny stumps,	*Astrophyton clavatum.*
	Upper disk and arms set with smooth grains of several sizes,	*Astrophyton exiguum.*
Five madreporic shields, one at inner angle of each interbrachial space.	Disk set sparsely with minute, short, slender spines, which are continued in groups of three along upper surface of arm,	*Astrophyton spinosum.*
	Disk covered with fine, close-set grains, which form cross ridges on the radial shields; and on the arms, belts alternating with those of the hooklets,	*Astrophyton cœcilia.*
	Disk and upper surface of arm set with spaced grains, which are fine and nearly equal,	*Astrophyton panamense.*

Astrophyton costosum, Seba (Pl. XXXV. figs. 17–25).

Astrophyton costosum, Seba (non Linck), vol. iii. p. 16, pl. ix. fig. 1, 1758; Lym., Ill. Cat. Mus. Comp. Zool., No. i. p. 192; Proc. Bost. Soc. Nat. Hist., vol. xix. pl. iv.
Euryale muricatum, Lmk., Hist. Anim. sans Vert., vol. ii. p. 538, 1816.
Astrophyton muricatum, Agas, Mém. Soc. Scien. Nat. Neuchatel, vol. i. p. 12; Müll. & Tr., Syst. Ast., p. 122; Ltk., Addit. ad Hist., part. 2, p. 156.

Bahia; 7 to 20 fathoms.

Astrophyton exiguum, Agas. (Pl. XLVII. fig. 1).

Astrophyton exiguum, Agas., Mém. Soc. Scien. Nat. Neuchatel, vol. i. p. 12, 1835; Müll. and Tr., Syst. Ast., p. 125, 1842.
Euryale exiguum, Lmk., Hist. Anim. sans Vert., vol. ii. p. 539.

In my notebook of 1861, I see "*Euryale exiguum*, Lamk., original of Peron and Lesueur, 1803; young." This prosaic line is poetical for me. It takes me back to the Jardin des Plantes as it was twenty years ago; and I can see the laboratories of the "Mollusques et Zoophytes," where I studied under the kindly direction of old Valenciennes. He has gone, and so has his successor, Deshayes, and their place is now worthily held by Professor Perrier, who was a very young man when first I knew him. But still that poor little broken *Astrophyton exiguum* lies on its shelf, the survivor of professors and of emperors.[1]

It was with a real emotion that, in unpacking the Challenger collection, I drew from a large jar two fine specimens. I felt like a scholar who had found a duplicate of the Codex Argenteus. After more than two generations the unique treasure of the Jardin des Plantes has at last other representatives. To celebrate its rediscovery I could not do less than give a figure of the animal.

Station 190 (young).—September 12, 1874; lat. 8° 56′ S., long. 136° 5′ E.; 49 fathoms; mud. Station 212.—January 30, 1875; lat. 6° 55′ N., long. 122° 15′ E.; 10 to 20 fathoms; sand.

Species of *Astrophyton* not herein described.

Astrophyton spinosum, Lym., Ill. Cat. Mus. Comp. Zool., No. viii. part 2, p. 29, figs. 44, 46, 1875.

Panama.

Astrophyton nudum, Lym., Ill. Cat. Mus. Comp. Zool., No. iii. part 10, p. 251, pl. vi. figs. 4, 5, 1874.

Philippines.

[1] Ill. Cat. Mus. Comp. Zool., No. viii. part 2, pl. iv. fig. 48, 1875.

Astrophyton cœcilia, Ltk., Vid. Meddel., p. 18, January 1856; Addit. ad Hist., part 2, p. 157, pl. v. fig. 6.

Astrophyton Krebsii, Örst. & Ltk., Vid. Meddel., p. 18, January 1856; Addit. ad Hist., part 2, p. 158, 1859.

West Indies; 73 to 125 fathoms.

Astrophyton clavatum, Lym., Proc. Bost. Soc. Nat. Hist., vol. viii. p. 85, 1861; Ill. Cat. Mus. Comp. Zool., No. i. p. 191.

Zanzibar.

Gorgonocephalus.

Gorgonocephalus, Leach, Zool. Miscell., vol. ii., 1815.

Disk thick and inclined to be circular, and, together with the arms, covered by a thick skin. Arms narrow at their base, and branching by a series of not numerous forks, having between them long, unequal shafts. Radial shields long and bar-like, composed of overlapping, soldered plates, and extending nearly or quite to centre of disk, thus forming more or less elevated radiating ribs. Margin of disk and inner angle of interbrachial spaces strengthened by irregular horizontal rows of plates. Teeth, tooth papillæ, and mouth papillæ all similar and spiniform. No true arm spines, but the outer branches have spiniform tentacle scales which, with the tentacles, are found quite to the base of the arm. Both the finer twigs and smaller branches are ringed with double lines of grains bearing microscopic hooks. Side arm plates confined to under surface and lower sides of arm. On the small branches the under arm plates are divided in three pieces, which increase in number towards the base of the arm, and there form an irregular pavement.

Upper arm plates represented by numerous thin, irregular plates, forming a mosaic. Two genital openings at the outer corners of the interbrachial spaces.

When I made a first section of a fine *Gorgonocephalus pourtalesii*, brought back by the Challenger, and whose swollen disk indicated a gravid individual, I expected to find a general arrangement of organs quite similar to that already known in such genera as *Ophiomyxa*. My astonishment was considerable when there was brought to light an internal economy which reminded one rather of an orange than of an *Echinoderm*. A horizontal cut, just above the joint of the radial shields, disclosed a quantity of membranous partitions stuffed with a sort of pulp and radiating in a confused manner; while a vertical section showed what might be a digestive cavity, surrounded by and communicating with a number of convolutions or blind sacks. The matter became clear only by giving up the idea that a strict correspondence with known forms was to be looked for.

Passing upward through the mouth of a *Gorgonocephalus*, and getting above the mouth papillæ (*d*) (Pl. XLV. fig. 2) and tentacles (*r*), we come to the usual contractile aperture, which may well be called the stomach sphincter (*du*). It is considerably wrinkled or even a little papillose on its border, and opens into a flattened digestive cavity (*St*). Thus far the structure is normal, but beyond this point all is novel. Instead of remaining simple, the digestive cavity passes outwards and upwards into a number of membranous pouches, which, in profile, present a fluted aspect (*St'*, *St''*). Their outer ends are attached in three ways; first (*St''*), they stretch upwards and are strongly fixed to the roof of the disk wall; secondly, they reach horizontally and grow to the inner points of the egg-bearing lobes (δ, δ); thirdly, they incline downwards, and are powerfully attached at ten points encircling the mouth. Of these points five are brachial (*St'*) (fig. 4) and five interbrachial (*St*). It is to the outer open angle of the mouth frames that the latter are attached, by a part of the floor of the digestive cavity, which is there much thickened (δ*f*) (fig. 2). Immediately above this attachment opens out the much folded and fluted interbrachial pouch (*St''*) (fig. 4), which, at its outer end, adheres to the inner points of the corresponding genital lobes; and, above, grows fast to the roof of the disk. In like manner there is a brachial attachment to the upper side of each arm (*St'*); and above it opens a brachial pouch which has a similar shape, and is made fast at corresponding places. From these ten points the attachment of the floor of the digestive cavity is continued outward over radiating lines, respectively across the interbrachial spaces and along the tops of the arms quite to the body wall. This structure would divide the body cavity in ten radiating compartments completely separated from each other, were it not that an open space exists (δ*f*) between the inner point of each attachment and the stomach sphincter (fig. 2). This open space corresponds to the ring canal surrounding the entrance to the stomach of *Ophiurans* (inner perihæmal canal, Ludwig), but differs in being a mere continuation of the body cavity and not a closed annular tube. It may be seen in wider section in fig. 4. The main digestive cavity directly above its own centre passes upwards to the roof of the disk as a simple cone, round which appear the folds of the radiating pouches (fig. 2). To give a general notion of this complex organ, we may suppose a large loose bag, having a hole at the bottom (mouth), and whose periphery is gathered in numerous radiating folds, leaving within a central flask-shaped open space communicating directly with these folds; and, further, that the folds are divided into ten lobes, and each lobe is attached at the bottom by a radiating adhesion.

The central portion of the digestive cavity was empty, but its lobes were stuffed with a coagulated, yellowish, pasty substance, which, either simple or with reagents, presented no special structure under the microscope, and which contained no organic remains. It might well be the decomposition of a thick layer, which had an hepatic character, or was simply epithelium.

The ovaries consist of deep, lobed, and contorted folds of the lining membrane of the disk wall on its floor, sides, and a portion of its roof. These folds are crammed with egg clusters, so as to resemble puddings or sausages (figs. 2 and 3, δ, δ); and, whatever their form, all end by adhering at their inner margins to the outer ends of the corresponding stomach pouches, whose basal lines of adhesion they also continue along the arms, and along the median line of each interbrachial space. As has been said before, the body cavity is thus divided into ten radiating compartments freely communicating at their inner ends by large holes through the partitions. A genital opening enters each of the compartments (fig. 3, *n*, *o*). *Gorgonocephalus*, therefore, has no closed bursa, with its cluster of genital tubes, but the entire body cavity, except the open (perihæmal) ring outside the mouth, is also the genital cavity. It was a similar arrangement that the older anatomists attributed to Ophiurans; and it is strange that their observations were true only of genera that had never been dissected.

As to internal composition, the ovarial lobes are uniform, and everywhere contain, under a thin, membranous envelope, crowded masses of egg clusters averaging about 1 mm. in length, and separated from each other by delicate membranous partitions (fig. 5). The eggs which compose each cluster are round, and about $\frac{1}{7}$ of a millimetre in diameter. The general envelope, as may be seen in the figure, becomes thicker at the free margin, and especially so at points where it grows to the stomach pouches. Its function of supporting the stomach points to its homology with those slender threads that suspend the Ophiuran stomach to the body wall. I was not able to detect on the surface of the ovarial lobes any pores for the egress of eggs, such as exist in the bursa of Ophiurans. It is therefore probable that the membrane ruptures at the breeding season, and the eggs are poured into the radiating compartments of the body cavity. Here the sea water might bring in spermatozoa for impregnation, after which the eggs of any compartment could be discharged through any one of the ten genital openings.

The chief difference between these organs in *Gorgonocephalus* and among Ophiurans is the greater specialisation in the latter, where the lining membrane of the disk wall becomes free, and enlarges opposite each genital opening into a closed pouch (bursa), which is extended in the form of finger-like tubes (ovarial tubes). In other words, the lining membrane, instead of being pierced by the genital opening, is continuous and simply becomes free and voluminous. In *Gorgonocephalus*, on the contrary, the genital opening pierces not only the disk wall but its lining membrane, and enters the body cavity, while nearly the whole of the lining membrane takes on the egg-bearing function, and by the growth of the eggs is gradually stretched and thrown into folded lobes.

TABLE OF SPECIES OF *Gorgonocephalus*.

One madreporic shield inside the raised mouth ring, and at base of a mouth angle. Disk covered by a fine, close, smooth granulation,	*Gorgonocephalus arborescens.*
Only one madreporic shield, which is situated at the inner angle of an interbrachial space. Disk set above and below with short tooth-like spines, which are longer and closer on radial shields,	*Gorgonocephalus lamarckii.*
Disk with small, smooth, scattered grains, which are more numerous on the radial shields,	*Gorgonocephalus eucnemis.*
Stands between the preceding and *Gorgonocephalus agassizii* (var. of *Gorgonocephalus eucnemis* (?),	*Gorgonocephalus malmgrenii.*
Similar to *Gorgonocephalus eucnemis*, but with closer, more regular granulation, and a strong row of grains along genital openings,	*Gorgonocephalus caryi.*
Disk set with a few small, irregular stumps, which are most numerous on outer ends of radial shields,	*Gorgonocephalus agassizii.*
Disk above closely beset with short, thick, thorny stumps; and below with very small short spines,	*Gorgonocephalus linckii.*
Disk similar to *Gorgonocephalus linckii*, but smooth below,	*Gorgonocephalus stimpsoni.*
Disk set above with scattered minute conical stumps, or stump-like granules. Arms in the adult nearly smooth,	*Gorgonocephalus pourtalesii.*
Similar to *Gorgonocephalus pourtalesii*, but structure more delicate. The young has a simple under arm plate, which is in several pieces in *Gorgonocephalus pourtalesii*,	*Gorgonocephalus chilensis.*
Disk finely and smoothly granulated, and set, together with upper surface of arms, with large smooth tubercles,	*Gorgonocephalus verrucosus.*
Radial shields set with fluted stumps. Tentacle scales flat, and strongly toothed at the end,	*Gorgonocephalus australis.*
Large conical spikes on upper disk, and upper surface of arms,	*Gorgonocephalus mucronatus.*
Five madreporic shields, one at inner angle of each interbrachial space. Surface of disk and arms smooth,	*Gorgonocephalus cacaoticus.*

Gorgonocephalus pourtalesii, Lym. (Pl. XLV. figs. 2–5).

Astrophyton Pourtalesii, Lym., Ill. Cat. Mus. Comp. Zool., No. viii. part 2, p. 28, pl. iv. figs. 41–43, 1875.

Astrophyton Lymani, Bell, Proc. Zool. Soc., p. 99, January 1880.

This widely spread animal is found from Heard Island to East Patagonia over a region between long. 70° E. and long. 70° W., 220 degrees in all, or more than half round the southern end of the world. The western specimens from Heard and Kerguelen Islands usually have the disk spines sharper and more numerous; and the basal shafts between

the arm forks are commonly shorter, as will appear by the following measurements of three Patagonian and three western specimens:—

Distance between Arm Forks outside of disk.	T. 4. original; East Patagonia. Disk 63 mm.	Between Falkland Island and Str. Magellan. Disk 80 mm.	Station 307. Disk 42 mm.	Station 151. Disk 37 mm.	Kerguelen Islands. Disk 62 mm.	Kerguelen Islands. Disk 70 mm.
1–2	16	27	19	10	16	21
2–3	32	36	22	18	18	26
3–4	30	37	16	18	18	25
4–5	27	34	25	23	20	21
5–6	29	22	33	22	19	20
6–7	27	18	26	26	22	22
7–8	15	24	26	17	22	15
8–9	10	12	21	19	16	14
9–10	7	11	20	18	13	12
10–11	7	8	32	16	12	10
11–12	4	7	...	11	11	10
12–13	...	5	...	6	10	5
13–14	...	3	...	...	10	...

Kerguelen Islands; 75 to 120 fathoms. Station 150.—February 2, 1874; lat. 52° 4′ S., long. 71° 22′ E.; 150 fathoms; rock. Station 151.—February 7, 1874; off Heard Island; 75 fathoms; mud. Station 307.—January 4, 1876; lat. 49° 24′ S., long. 74° 23′ W.; 147 fathoms; mud. Station 308.—January 5, 1876; lat. 50° 10′ S., long. 74° 42′ W.; 175 fathoms; mud. Station 313.—January 20, 1876; lat. 52° 20′ S., long. 68° 0′ W.; 55 fathoms; sand. Off East Patagonia; 55 to 144 fathoms.

Gorgonocephalus verrucosus, Lym. (Pl. XLVIII.).

Euryale verrucosum, Lmk., Hist. Anim. sans Vert., vol. ii. p. 537, 1816.
Euryale verrucosum, Cuvier, Règne Anim., Zooph., pl. v., 1817.
Astrophyton scutatum, Agas., Mem. Soc. Scien. Nat. Neuchatel, vol. ii. p. 11, pl. i. to iii., 1839.
Astrophyton verrucosum, Müll. & Tr., Syst. Ast., p. 121, 1842.

This is a somewhat aberrant member of the genus. There are no scales or pieces homologous with upper or under arm plates, in which respect it approaches *Astrophyton*. The side arm plates are, however, by no means so large as in that genus, being short, thin plates covering only a part of the under surface of the arm. A character of similar significance is the absence of any row of plates along the margin of the disk. The hook belts are confined to the terminal twigs. It approaches *Astrophyton* also in the great

number of forkings,[1] and in the comparative equality in length of the intermediate shafts. While a large *Gorgonocephalus agassizii* would have not more than a dozen or fourteen forkings from the main stem, this species has more than thirty; and the twigs from each of these forkings are generally very rich in forks. In this respect, however, the left stem is very poor as compared with the right. For example, the twelfth twig of the left stem has but eight forks, while the twelfth of the right stem has nearly three hundred. Some of the twigs on the outer part of the right stem have more forks than those further in; thus No. 12 has more than No. 5.

Simon's Bay, Cape of Good Hope; 10 to 20 fathoms.

Species of *Gorgonocephalus* not herein described.

Gorgonocephalus arborescens, Agas., Mém. Soc. Scien. Nat. Neuchatel, vol. ii., pls. iv., v., 1839.

Stella arborescens, Rondelet, De Pisc., p. 121, 1554.
Euryale costosum, Lmk., Hist. Anim. sans Vert., vol. ii. p. 538, 1816.
Astrophyton costosum, Agas., Mém. Soc. Scien. Nat. Neuchatel, vol. ii. p. 11, 1839 (*Gorgonocephalus* in the plates).
Astrophyton arborescens, Müll. & Tr., Syst. Ast., p. 124, 1842; Lym., Ill. Cat. Mus. Comp. Zool., No. i. p. 181; Bull. Mus. Comp. Zool., vol. i., part 10, p. 313, note; Ludwig, Echin. des Mittelmeeres, p. 552.

Mediterranean; West Indies.

Gorgonocephalus lamarckii, Lym.

Asterias caput medusæ (?), Linn., Fauna Suecica, 1761, No. 2115.
Astrophyton Lamarckii, Müll. & Tr., Syst. Ast., p. 123, 1842.

North European Seas.

Gorgonocephalus eucnemis, Lym.

Asterias caput medusæ, Fabr., Fauna Groenl., No. 367, 1780.
(?) *Zottenkopf*, Knorr Deliciæ Nat. Select., vol. ii. p. 34, pl. G, figs. 1, 2, 1787.
Asterias caput medusæ, Dewhurst, Nat. Hist. Ord. Cetacea.
Astrophyton eucnemis, Müll. & Tr., Syst. Ast., p. 123, 1842; Ltk., Addit. ad Hist., part 1, p. 70, pl. ii. figs. 17–19; Lym., Ill. Cat. Mus. Comp. Zool., No. i. p. 181.

Greenland; N. E. North America.

[1] See T. Lyman, Mode of Forking among Astrophytons, Proc. Bost. Soc. Nat. Hist., vol. xix. p. 7, March 1877.

Gorgonocephalus agassizii, Lym. (Pl. XXXV. fig. 26; Pl. XXXVI.).

The Basket Fish, J. Winthrop, Phil. Trans. Roy. Soc., vol. v. p. 1152, 1670, vol. vi. p. 2221, 1671.
Astrophyton scutatum scuto rotato (?), Linck, De Stell, Mar., p. 65, pls. xxix., xxx.
Euryale scutatum, Gould (non De Blainville), Invert. Mass., p. 345, 1841.
Astrophyton Agassizii, Stimp., Invert. Gr. Manan, Smith. Contrib., vol. vi. p. 12, 1853; Lym., Ill. Cat. Mus. Comp. Zool., No. i. p. 186; Proc. Bost. Soc. Nat. Hist., vol. xix., pl. v.

Cape Cod to Gulf of St. Lawrence.

Gorgonocephalus linckii, Lym.

Asterias scutatum (pars), Linck, De Stell. Mar., pl. xxix. No. 48. *See Sonne*, Pontoppidan Natur. Hist. Nor., vol. ii. p. 369.
Asterias caput medusæ (?), Linn., Fauna Suecica, No. 2115.
Astrophyton Linckii, Müll. & Tr., Syst. Ast., p. 122, 1842; Lym., Ill. Cat. Mus. Comp. Zool., No. i. p. 190.

North European Seas.

Gorgonocephalus malmgrenii, Lym.

Astrophyton Malmgrenii, D. C. Danielssen, Magazin for Naturvid, p. 37 (of separate copy), 1877.

62° 44′ N., 1° 46′ E.; 64° N., 5° 35′ E.; 400 to 510 fathoms.

Gorgonocephalus caryi, Lym.

Astrophyton Caryi, Lym., Proc. Bost. Soc. Nat. Hist., vol. vii. p. 424, 1860; Lym., Ill. Cat. Mus. Comp. Zool., No. i. p. 184.

San Francisco, Cal.

Gorgonocephalus panamensis, Lym.

Astrophyton panamense, Vll., Trans. Conn. Acad., vol. i., part 2, p. 251, 1867.

Panama.

Gorgonocephalus stimpsonii, Lym.

Astrophyton Stimpsonii, Vll., Proc. Bost. Soc. Nat. Hist., vol. xii. p. 388, 1869.

Ochotsk Sea.

Gorgonocephalus cacaoticus, Lym.

Astrophyton cacaoticum, Lym., Bull. Mus. Comp. Zool., vol. iii., part 10, p. 250, 1874.

Guadeloupe; 20 fathoms.

Gorgonocephalus australis, Lym.

Astrophyton australe, Vll., Contrib. to Nat. Hist. of Kerguelen Island, by J. H. Kidder, vol. ii. p. 74, 1876.

Tasmania; 7 fathoms.

Gorgonocephalus chilensis, Lym.

Astrophyton chilense, Phil., Wieg. Archiv, p. 268, 1858.

Chili.

Gorgonocephalus mucronatus, Lym.

Astrophyton mucronatum, Lym., Bull. Mus. Comp. Zool., vol. i., part 10, p. 348, 1869.

Florida; 120 to 125 fathoms.

Euryale.

Euryale, Lmk., Hist. Anim. sans Vert., vol. ii., 1816.

Disk re-enteringly curved in the interbrachial spaces, and, together with the arms, covered by thick skin. Arms pretty wide at their base and branching by a series of numerous forks having between them shafts which grow suddenly shorter towards the extremities.[1] Radial shields long, bar-like, and in one piece, and extending nearly to centre of disk, so as to form more or less elevated radiating ribs. Entire interbrachial space below covered by stout plates soldered together. A vertical row of stout teeth, like those of Ophiurans, but no mouth papillæ, nor tooth papillæ. No proper arm spines, but the outer branches have peg-like tentacle scales which are continued nearly to the base of the arm. There are small, simple under arm plates similar to those among Ophiurans. Side arm plates at end of arms like long, free flaps, bearing hooks (tentacle scales): further in they are small and cling close to the arm, and rise scarcely above its under surface. Upper arm plates represented by a double line of small pieces, which support two large spines standing on the upper surface of the arm. Two genital opening at outer corners of each interbrachial space.

A section of a *Euryale* (Pl. XLV. fig. 6) shows the aspect of a non-gravid individual, the pouches of whose digestive cavity are nearly empty, instead of being stuffed with the clotted substance mentioned under *Gorgonocephalus*. Above is seen the digestive cavity, which, on the right and left, passes into pouches; and partitions, forming similar pouches, may be seen on the farther side of the centre. Above the lateral pouches are the radial shields (*l,l*) cut through. On the extreme right and left are greatly dilated genital openings (*n,o*), which lead directly into the body cavity; and this, passing under and outside the digestive cavity, is connected, about the mouth, by the perihæmal canal, a cross cut of which appears at *δf*. A section of the disk skin, above the body cavity, (fig. 7) exhibited a uniform, tough, slightly fibrous composition, with a thin lining

[1] For the mode of branching, see T. Lyman, Proc. Bost. Soc. Nat. Hist., vol. xix., March 1877.

membrane, not well defined, and of a granular texture (fig. 8) under a high power indicating perhaps egg-cells. Of fully formed eggs, however, there were none, and the lining membrane was not thrown into lobes or convolutions. If, however, the ovaries were distended, and the pouches of the digestive cavity filled with matter, the general appearance would approach that of *Gorgonocephalus*, except that the pouches would be simpler; and the ovaries would be much more restricted in area, unless, indeed, the lining membrane of the body cavity to which the wall of the digestive cavity adheres has the power to develop egg clusters, and thus form lobes, and push the digestive cavity inward towards the mouth.

It will be noticed that the genital openings are greatly distended, which shows that the animal can contract or expand them, since, in other specimens, they were tightly shut and reduced to a small slit. The attachments of the digestive cavity to the inner open angle of the mouth frames are not so thick and muscular as in *Gorgonocephalus*, so that the perihæmal canal is flattened, instead of more or less erect and rounded. Nevertheless there are the same ten radiating attachments respectively along the tops of the arms and the middle of the interbrachial spaces, dividing the body cavity into ten compartments, which freely communicate at their inner ends by the perihæmal canal. In the lining membrane of these compartments were found numerous fragments of microscopic lime network (fig. 9) similar to that which exists in the walls of the bursa of *Ophiura lævis* and *Ophiocoma scolopendrina*.[1] It is these that, by their further growth, make the thin scales which clothe the wall of the bursa in *Ophiothamnus vicarius*.

A section of a species from an allied genus, *Astrophyhyton costosum*, showed a general structure very like that of *Gorgonocephalus*.

Euryale aspera, Lmk. (Pl. XXXV. figs. 1–16; Pl. XLV. figs. 6–9).

Euryale aspera (*asperum*), Lmk., Hist. Anim. sans Vert., vol. ii. p. 538, 1816.
Astrophyton scutatum (pars), Linck, De Stell. Mar., pl. xx. fig. 32, 1733.
Capitis medusæ altera species minor supina, Seba, Thes., vol. iii., pl. ix., 1761.
Astrophyton asperum, Agas., Mém. Soc. Scien. Nat. Neuchatel, vol. ii. p. 12, 1839; Müll. & Tr., Syst. Ast., p. 124; Lym., Proc. Bost. Soc. Nat. Hist., vol. xix., pl. vi.
Astrophyton lævipelle, Grube, Jahres-Berichte d. Sch. Gesell., p. 44, 1869.

Station 186.—September 8, 1874; lat. 10° 30′ S., long. 142° 18′ E.; 8 fathoms; coral sand. Station 203.—October 3, 1874; lat. 11° 7′ N., long. 123° 7′ E.; 12 to 20 fathoms; mud.

Trichaster.

Trichaster, Agas., Mém. Soc. Scien. Nat. Neuchatel, vol. i., 1835.

A nearly smooth skin covers both disk and arms, whereof the latter fork a few times,

[1] Hubert Ludwig, Beiträge zur Anatomie der Ophiuren, Zeitschr. für Wissenschaft, Zoologie, Bd. xxxi., figs. 27, 28, 1878.

but only near their ends. Teeth, but no tooth papillæ, and only a few small mouth papillæ irregularly arranged high up on the sides of the mouth angle. At the tips of the twigs the side arm plates are like long flaps, free of the arm and bearing at their ends a pair of little hooks. Further inward they cling close to the arm and take on the usual form of such plates, while the hooks become spine-like tentacle scales (or arm spines). The side arm plates, connected below by a solid under arm plate, are continued upward by swollen lime nodules homologous with upper arm plates. Large side mouth shields, but no mouth shield proper. Two small genital openings in each interbrachial space, between which is a fine madreporic pore leading into a stone canal.

Species of *Trichaster* not herein described.

Trichaster palmiferus, Agas., Mém. Soc. Scien. Nat. Neuchatel, p. 193, 1835; Müll. and Tr., Syst. Ast., p. 120, 1842.

Euryale palmiferum, Lmk., Syst. Anim. sans Vert., vol. ii. p. 539, 1801: Encycloped. Meth., p. 384, pl. cxxvi.
Astrophyton palmiferum, Bronn, Syst. d. urweltl. Pflanz., pl. ii. fig. 3.
Trichaster flagellifer, V. Mart. Wieg. Archiv, vol. xxxii. p. 87, 1877.

India.

Trichaster elegans, Ludwig, Zeits. für Wissen. Zoologie, vol. xxxi. p. 59, 1878.
Great Ocean.

Astroclon.

Astroclon, Lym., Bull. Mus. Comp. Zool., vol. vi., part 2, 1879.

Arms beginning to branch at a considerable distance from the disk, and having but few forks, nearly as in *Trichaster*. Disk rising well above the arms, and granulated, as are the latter. The tips of the twigs are encircled at each joint by a double belt of hook-bearing grains. Along the under surface of the base of the arm are two longitudinal lines of large, transverse slits, a pair to each joint, from which issue short tentacles; and above these on either side is a row of peg-like tentacle scales. Mouth angles naked on their sides, but with a bunch of spine-like papillæ at the apex. Two very large genital openings in each interbrachial space.

Astroclon propugnatoris,[1] Lym. (Pl. XXIV. figs. 6–11).

Astroclon propugnatoris, Lym., Bull. Mus. Comp. Zool., vol. vi., part 2, p. 69, pl. xviii. figs. 481–486, 1879.

Animal covered above by a closely soldered granulation, in which appear numerous

[1] Dr. Carpenter has happily translated Challenger by προμαχος, the Homeric word for a champion who stood in front of the line of battle and challenged the leaders of the enemy. *Propugnator* is a verbal translation, although it seems usually to signify rather a defender. I am told by high authority, however, that its present use is allowable. Goliath was such a challenging champion, but he is described in the Vulgate as *vir spurius*, an expression not applicable here.

dark patches, which are small, oblong, smooth plates, sometimes raised like tubercles, and sometimes sunken. Below, the granulation is microscopic, and, on part of the under surface of arm, wanting. Five short, wide, smooth tentacle scales.

(Type specimen from Station 192.) Diameter of disk 65 mm. Length of arm, from disk to first fork, 160 mm.; from first fork to second, 36 mm.; second to third, 137 mm.; third to fourth, 26 mm.; fourth to fifth, 16 mm.; fifth to sixth, 16 mm.; sixth to end, 16 mm.; total, 407 mm. Width of arm near disk 14 mm.; height at same point 10 mm. Mouth angles small, and on their sides smooth, bearing at the apex a vertical tuft of small, smooth, short, spine-like papillæ. From near mouth to margin of disk the arms grow wider, but begin to taper from that point. They are cleanly arched above, but flat on the lower surface, a large portion of which is occupied by the deep, oblong transverse pits (the largest 3·5 mm. long) on whose inner side stand the tentacles, so that this surface presents the appearance of a central, radiating strip, on whose sides are the tentacle pits, arranged like the feathers of an arrow. This central strip has a very fine granulation, nearly obscured by skin; but the lateral region is quite smooth. The sides and upper surface are covered by a coat of soldered grains, about two in the length of 1 mm. Among them appear numerous small, smooth, slightly sunken, rounded, dark plates, usually 1·5 mm. in diameter; these begin near the tip, with a single plate on the upper surface of each joint, and gradually increase in number towards the base of the arm. The terminal twigs are encircled by double belts of hook-bearing grains (fig. 11), but the intervening spaces are not yet granulated. Disk thick, rising well above arms; covered above by a soldered granulation similar to that of the arm, with scattered smooth plates, which sometimes are raised and sometimes sunken. Interbrachial spaces below covered by a minute granulation, which is more or less obscured by skin, and seems smooth to the naked eye. Radial shields not externally indicated. Genital openings very large, extending from opposite the second tentacle pit nearly to margin of disk, and capable of great distention; one of them was open to the width of 9 mm. The mouth tentacles and first pair on the arm have no tentacle scales; thence to margin of disk there are two or three, minute and peg-like, to each tentacle; for some distance beyond the margin each tentacle has five small, thick, short, wide scales, about 1·5 mm. long, arranged in a single line. Colour in alcohol, uniform yellowish-brown, with chocolate patches where the smooth plates are.

Station 192.—Sept. 26, 1874; lat. 5° 42′ S., long. 132° 25′ E.; 129 fathoms; mud.

The single specimen had lost one arm and a piece of the disk, the result apparently an injury, and not of self division.

Astrocnida.

Astrocnida, Lym., Ann. Sci. Nat., 1872.

Disk divided into five radiating wedges by the pairs of radial shields, and, together with the arms, covered by a minute pavement of flattened granules. The arms fork a few times, but only near their ends. Teeth, tooth papillæ, and mouth papillæ all similar and spiniform. Side arm plates confined to under surface of arm and bearing several rough, cylindrical tentacle scales (or arm spines). These plates are continued upward by a double row of lumpy nodules homologous with upper arm plates, which bear minute hooks, and which are continued over the roof of the disk, as irregular, concentric circles of short, blunt spikes, or large granules bearing hooks. Two small genital openings in each interbrachial space at the outer corners.

A specimen of the rare *Astrocnida isidis* from the "Blake" dredgings afforded a chance to examine a branching star, like *Astrogomphus* in outward appearance, but resembling *Trichaster* in its few and widely-spaced arm forks. On making a vertical section through the disk (Pl. XLVI. fig. 2), a curious and quasi-intermediate structure is exposed. The digestive cavity recalls *Gorgonocephalus* in that it is more or less pleated and pouched (*St'*), and is firmly attached to the roof of the disk wall; but it is Ophiuroid in being entirely free below, and partly so on its sides, having no radiating lines of attachment, either along the arms, or in the interbrachial spaces. The only vestige of such attachments is a stout septum, such as is found in Ophiurans lying outside the wall of the stomach sphincter (*du*), and thus forming a closed ring tube (inner perihæmal canal). It may more properly be called an adhesion of the floor of the digestive cavity to the wall of the mouth where they are doubled over each other. Between the upper side of the digestive cavity and the disk wall, and on top, and on either side of each arm, lie the ovaries (*ô*), which consist of almost separated ovoid egg clusters, rather more than 1 mm. in length, containing round eggs about 2 mm. in diameter. They are not connected with, or surrounded by any bursa, but lie directly in the body cavity, into which penetrate the genital openings. The genital organs are therefore strictly of an *Astrophyton* type, and discharge their products into the body cavity, which is continuous and uninterrupted by radiating partitions.

Astrocnida, and behind it *Astrogomphus*, is nearest in relationship to the true Astrophytons. Not only does the arm covering, with its double rings of minute hooks shadow forth an affinity, but the internal structure, with a pouched digestive cavity and ovaries lying free in the general body cavity is similar; while the want of adhesions on the under side of the digestive cavity and the closed ring tube about the mouth remind us of the Ophiurans. But in reaching after some form which may bridge the way to these last, we find, as generally happens in the animal kingdom, no piece that will fit. *Ophiocreas*, which is properly a simple armed *Astrophyton*, is not intermediate. It is a synthetic form. It has the teeth of *Euryale*, the pleated digestive cavity suggestive of *Gorgonocephalus*, the genital bursa and ovarial tubes similar to, yet not the same as, those of Ophiurans in

general, the arm plates that recall *Ophiomyxa;* nay, one *Astrophyton* character, the adhesion of the digestive cavity to the disk wall, is carried farther than in *Astrophyton* itself.

In conclusion, it is proper to point out a slight resemblance which the branching Astrophytidæ have to the order of Starfishes. This is in the pouches of the digestive cavity filled with a clotted matter, which suggest the varied cæcal appendages characteristic of different genera among Asteroidea.

Species of *Astrocnida* not herein described.

Astrocnida isidis, Lym. (Pl. XLVI. fig. 2).

Astrocnida isidis, Lym., Ann. Sci. Nat., 1872, p. 1.
Trichaster isidis, Duchassaing, Animaux Radiaires des Antilles, 1850.

West Indies; 56 to 120 fathoms.

Astroporpa.

Astroporpa, Örst. & Ltk., Vid. Meddel., Jan. 1856.

Disk divided into five radiating wedges by the pairs of radial shields and covered, together with the arms, by a minute pavement of flattened granules, which below are more scattered and rounded. The arms are simple, and their under surface is almost covered by the side arm plates which bear several rough cylindrical, tentacle scales (or arm spines). These plates are continued upward by a narrow, regular double line of close-set nodules, homologous with upper arm-plates, and bearing minute hooks. They thus form very regular raised belts on the arms, and are continued over the back of the disk as irregular concentric circles, of which the outer ones are hook bearing, like those of the arms, and those nearest the centre have often microscopic thorns, the remains of hooks. Two small genital openings in each interbrachial space at the outer corners.

Here is an excellent illustration of the homology between the roof of the disk, and the top and sides of the arms, or of the fact that the skin of the latter is a prolongation and a bending down of the skin of the roof. Seen from above, an *Astroporpa* looks as if composed only of five arms, whose bases were thickened and wedged together to form the disk, an effect heightened by the continuation of the hook-bearing ridges from belts on the arms to concentric circles on the disk. *Astrogomphus* has in place of them rather irregularly disposed spikes, while *Astrocnida* has pretty well-marked circles, some of which bear hooklets, while others are simple spikes.

Species of *Astroporpa* not herein described.

Astroporpa annulata, Örst. & Ltk., Vid. Meddel., Jan. 1856, p. 17; Addit. ad Hist., part 2, p. 152.

Astroporpa dasycladia, Duj. & Hupé, Hist. Nat. Zooph. Echin., p. 298, 1862.

Barbadoes; 100 fathoms. West Indies; 50 fathoms.

Astroporpa affinis, Ltk., Addit. ad Hist., part 2, p. 154, pl. v. fig. 5, 1859.
West Indies; 50 fathoms.

Astrogomphus.

Astrogomphus, Lym., Bull. Mus. Comp. Zool., vol. i., part 10, 1869.

Disk traversed by ten narrow radiating ridges formed by the radial shields; it, as well as the arms, is covered with a minute pavement of flat granules some of which, on the former, become short stout spikes. Teeth, tooth papillæ, and mouth papillæ all similar and spiniform. The arms are simple, and their under surface is almost wholly covered by side arm plates, which meet in the centre, and which bear several rough, cylindrical, tentacle scales (or arm spines). These plates are continued upwards by a double row of lumpy nodules, homologous with upper arm plates, which bear minute hooks. No under arm plates. Two small genital openings in each interbrachial space at the outer corners.

Through *Astrocnida*, *Astrogomphus* approaches the typical Astrophytons, having the arm belts of minute hooks, and an arrangement of side arm plates, which, with the absence of under arm plates, reminds one of *Astrophyton costosum*. The radial shields also are made up of several overlapping pieces soldered together (Pl. XLIV. figs. 10, 11, *l*). Attached is a short, somewhat flattened, genital plate (fig. 10, *o*), to which adheres a flat and very short genital scale. The small mouth angles are very simple, and somewhat recall the shape in *Ophioscolex*. Besides a solid transverse oval peristomial plate (fig. 12, *v*), there is another little piece just at the upper outer corner of the mouth slit, which Ludwig considers the true first under arm plate, and calls what usually is described as the first the second.

As might be expected in genera somewhat closely allied, *Astrogomphus* has an arrangement of the reproductive and digestive organs entirely comparable to that of *Astrocnida*, except that the folds of the stomach are less complex and numerous.

See Plate XLIV. figs. 10–12.

Species of *Astrogomphus* not herein described.

Astrogomphus vallatus, Lym. (Pl. XLIV. figs. 10–12).

Astrogomphus vallatus, Lym., Bull. Mus. Comp. Zool., vol. i., part 10, p. 350, 1869; Ill. Cat. Mus. Comp. Zool., No. vi, pl. i. figs. 16–18; Bull. Mus. Comp. Zool., vol. v., part 9, p. 236.

West Indies; 128 to 270 fathoms.

Astrochele.

Astrochele, Vll., Am. Journ. Scien., vol. xvi., 1878.

Disk traversed by the narrow radiating ridges formed by the radial shields, and with the arms covered by small rounded scales, or grains, more or less obscured by a thick skin. Teeth, tooth papillæ, and mouth papillæ all similar and spiniform. The arms are

simple and the side arm plates lie on the under surface and bear several rough, cylindrical tentacle scales (or arm spines). These plates are continued upward by a double row of large grains, homologous with upper arm plates, which bear minute hooks. Two small genital openings in each interbrachial space at the outer corners.

This genus differs outwardly from *Astrogomphus* chiefly in having no spikes on the disk, and in having disk scales of a different character.

Species of *Astrochele* not herein described.

Astrochele lymani, Vll., Am. Journ. Scien., vol. xvi. p. 374, 1878.
N.E. Coast of North America; 200–980 fathoms.

Astrotoma.

Astrotoma, Lym., Ill. Cat. Mus. Comp. Zool., No. viii. part 2, 1875.

Disk arched and traversed above by ten low radiating ridges formed by the radial shields, and closely granulated. There are no mouth papillæ, and the spiniform teeth and tooth papillæ form an irregular clump at the apex of the mouth angle, somewhat as in *Astrophyton*. The arms are simple and the side arm plates are confined to their lower surface, and bear several peg-like scarcely rough, tentacle scales (or arm spines). These plates are continued upwards by a double row of granules bearing minute hooks which are encased in thick skin bags. The annular ridges thus formed are wide and rather indistinct. Two small genital openings in each interbrachial space, at the outer corners.

Astrotoma agassizii, Lym., Ill. Cat. Mus. Comp. Zool., No. viii., part 2, p. 24, pl. iv. figs. 57, 58, 1875.
Straits of Magellan; 135 fathoms.

Astrotoma murrayi, Lym. (Pl. XXII. figs. 5–7).

Astrotoma Murrayi, Lym., Bull. Mus. Comp. Zool., vol. vi., pt. 2, p. 61, pl. xviii. figs. 474–476, 1879.

Large tubercles, or smooth warts, on the upper side of disk. No hooklets on belts of grains on arms, except close to their tip. Clusters of grains in interbrachial spaces next mouth.

(Type specimen from Station 194.) Diameter of disk 29 mm. Length of arm 280 mm. Width of arm near disk 7 mm. Height of arm near disk 7 mm. Apex of mouth angle, embracing all the region of the jaw plate, densely set with short, sharp, nearly equal, spine-like papillæ, thirty or more in number, and arranged in transverse rows of three or four. Lower surface and a part of the sides of the protuberant mouth angles closely set with rounded and sometimes elongated grains. One round madreporic mouth shield, 1·5 mm. in diameter, lying on the margin of the horizontal mouth region, where it is separated from the vertical interbrachial space by a fold of skin stretched between the bases of the arms. Arms high, and tapering gradually to their tips, covered

above and on the sides by belts of granules alternately raised and sunken. In the former, the granules are larger and more distinct, and are more or less regularly arranged in four rows, whereof two at tip of arm bear minute, simple hooks, which, however, are soon rubbed off. In the latter, the granules are minute and arranged as a smooth pavement, in which appear many oblong holes or depressions. On its under surface the arm is covered by a cross wrinkled, calcified skin, on which are scattered granules. Disk flat and angular, with re-entering curves in the interbrachial spaces; the radial shields, whose outlines are vaguely defined, are broad, and run nearly or quite to the centre. The upper surface is covered by a smooth pavement of small, soldered grains, among which appear small oblong depressions, and on whose surface are scattered a few large, smooth tubercles. The interbrachial spaces below are covered by a clump of large, coarse grains; at the inner end of each of these spaces is a deep, transverse hollow, at either extremity of which is a short, genital opening. Between the mouth slit and the lower margin of disk there are no tentacle scales; but, beyond, each pore has four, rarely five, stout, smooth, peg-like scales, lying side by side, and nearly as long as an arm joint; nearer tip of arm there are but three. Colour in alcohol, reddish-brown, the disk tubercles and clumps of grains about mouth being darker.

Station 194.—September 29, 1874; lat. 4° 33′ S., long. 129° 58′ E.; 200 fathoms; volcanic detritus.

Astroschema.

Astroschema, Örst. & Ltk., Vid. Meddel., 1856.

Disk very small, slightly arched, divided into radiating lobes by the radial shields, and covered by a granulated skin. Large strong teeth in a single vertical row, as among Ophiurans. No mouth papillæ or tooth papillæ. Arms simple, very long and slender, and covered by a granulated skin, which completely hides underlying parts; their under side is almost covered by the side arm plates (Pl. XLIV. fig. 4, *i*), which bear two slightly rough, cylindrical tentacle scales (or arm spines), and are continued upwards by a row of narrow plates (*j*) homologous with upper arm plates, and covering the sides and top of the arm. Under arm plate small and shield shaped (*h*). Two small genital openings in each interbrachial space, slanting or nearly vertical, and placed at the outer corners.

The skeleton of *Astroschema* is marked by compactness and solidity, the mouth frames are especially (fig. 1, *f*) strong, simple, and destitute of wings. At their inner angle is a piece (*v′*) which has been homologised as the first under arm plate. In this case it resembles the peristomial plate which is not represented in the drawing. A small, short jaw (*c*) supports a little plate (*e*), and this carries the large teeth (*d″*). Outside the mouth frames is seen the first free arm bone, solid, simple, and discoid, whose outer and inner faces (figs. 2, 3) show the true hour-glass joint. More strongly made even than the preceding parts are the radial shield (*l*) and genital plate (*o*). To the latter is soldered a rudimentary genital scale (*n*). Above the simple under arm plate (fig. 5, *i*) come the pieces of the

upper plate, and from it issues the tentacle (*x*), while below is attached the rough, cylindrical tentacle scale or arm spine.

In several respects this genus leans towards the Ophiuridæ; as in its large teeth in a single row, its solid radial shields, and its well formed under arm plates.

TABLE OF SPECIES OF *Astroschema*.

	Diameter of Disk to length of Arm.	Width of Arm to diameter of Disk.	Grains in 1 mm. long on upper arm at its base.		
Disk and arms beset with minute conical spines, or sharp grains.	1 : 15	1 : 3	4	Disk spines set on little plates which pave the disk and arms.	*Astroschema horridum.*
	1 : 17	1 : 3	4–5	Disk grains sharp, even far out on arms. Tentacle scales not anywhere longer than a joint, and scarcely clubbed.	*Astroschema oligactes.*
	1 : 17	1 : 3½	5	Grains far out on arms, rounded. Tentacle scales often as long as 1½ joints, but scarcely clubbed.	*Astroschema tumidum.*
Disk and arms covered by a smooth granulation.	arm moderate.	1 : 2½	4	Disk grains close-set, smooth, and very large.	*Astroschema arenosum.*
	1 : 15	1 : 2½	9–15	Disk grains very fine, smooth, and even. Two tentacle scales do not begin till beyond the eighth pore.	*Astroschema læve.*
	1 : 10	1 : 3	7–8	Arms short. Disk flat and even. Under tentacle scale at end of arm becomes a compound hook.	*Astroschema salix.*
	1 : 13	1 : 3½	6–7	Mouth tentacles in tubes. Lower tentacle scale, near end of arm, very long but not clubbed.	*Astroschema rubrum.*
	1 : 15	1 : 3	...	Disk grains spaced and arranged in concentric lines.	*Astroschema steenstrupii.*
	arm long.	...	12	No tentacle scale till fourth pore, then one till the twelfth, after which two (an ill-defined species).	*Astroschema sulcatum.*
	1 : 33	1 : 4	8–9	Arms extremely long and thin	*Astroschema tenue.*
	1 : 24	1 : 4	6–9	Arm much higher than wide.	*Astroschema brachiatum.*
Arm granulated above, but naked below.	1 : 24	1 : 7	7	. . . .	*Astroschema intectum.*

Astroschema horridum, Lym. (Pl. XXX. figs. 1–4).

Astroschema horridum, Lym., Bull. Mus. Comp. Zool., vol. vi., part 2, p. 66, pl. xvii. figs. 458–461, 1879.

Entire surface covered with little, swollen, oblong angular plates or scales, bearing minute points.

(Type specimen from Station 170.) Diameter of disk 12·5 mm. Length of arm 195 mm. Width of arm near disk 4·7 mm.; height of arm 4·2 mm. Seven stout, thickened, rather small teeth, of the usual short spearhead shape. The mouth angles are paved with large, flattened, swollen grains, but have no true papillæ. Arms nearly cylindrical, very slightly swollen for their first 20 mm., beyond which they taper very regularly. They are evenly and pretty closely beset with minute points, like little blunt spines, about 4 in the length of 1 mm.; these, on allowing the surface to dry, are seen to stand on small, swollen, oblong, angular plates or scales, which may be considered as exaggerated grains set with points. This covering continues quite to the end of the arm, where, however, the grains are more rounded and without points. Disk thick, rising a little above the arms, elegantly scalloped on its margin, with large radial shields (ribs), which are thick, swollen, and projecting at their outer ends, and taper inward to the centre where they meet; its surface is paved with little oblong, angular, swollen plates or scales, rather coarser than those of the arms, and bearing similar minute points. Genital openings straight, and occupying about one-half the height of the disk. Mouth tentacles enclosed in a tube of flat grains; the next pair has no tentacle scale; the next one and those beyond have two, which are short at first, but about 40 mm. out become somewhat suddenly elongated, the upper one, about 1·3 mm. in length, remaining blunt, spiniform, while the lower and larger takes on the form of a cylinder 3 mm. long, with a rough, swollen end. The two lines of pores lie closer together than usual, so that the furrow on the lower side of the arm is narrow. Colour in alcohol, pale reddish-brown.

Station 170.—July 14, 1874; lat. 29° 45′ S., long. 178° 11′ W.; 600 fathoms.

Astroschema tumidum, Lym. (Pl. XXII. figs. 8–12).

Astroschema tumidum, Lym., Bull. Mus. Comp. Zool., vol. vi., part 2, p. 68, pl. xvii. figs. 450–453, 1879.

Disk and arms covered by regularly spaced, pointed, conical grains. The bases of the arms for two or three joints are strongly swollen.

(Type specimen from Station 192.) Diameter of disk 8 mm. Length of arm 135 mm. Greatest width of arm close to disk 3·7 mm. Width beyond the swelling 2·3 mm. Height of arm at same point 1·8 mm. Seven or eight short, flat teeth, with a curved cutting edge; the lowest one smallest. The general granulation of the disk is continued in a somewhat coarser form over the mouth angles, and up their sides; but

there are no true mouth papillæ. Arms well rounded, without any flattened surface, strongly swollen and ribbed, for the first two or three joints, but even and tapering beyond; set with pointed conical grains which are regularly spaced, about five in the length of 1 mm., and which rarely touch each other. Disk strongly contracted in interbrachial spaces, and occupied chiefly by the high, wide radial shields (or ribs) which run quite to the centre; granulation somewhat more sparse than on arms. On first arm pore there is no tentacle; the next has one, cylindrical, tapering and blunt, with sometimes a second rudimentary one; the pores beyond have two, whereof the upper one is, as usual, much the smaller. One-third out on the arm, the larger scale attains a length of 2 mm., and is rough at the end and slightly clubbed. Colour in alcohol, pale yellowish-brown, with interbrachial spaces of disk grey.

Station 192.—September 26, 1874; lat. 5° 42′ S., long. 132° 25′ E.; 129 fathoms; mud.

This species presents the same swelled base of the arm found in *Ophiocreas œdipus*, and, doubtless for the same purpose, an egg-pouch. The genera *Astroschema* and *Ophiocreas*, though differing widely in their remote members, are, in their proximate species, only distinguished by surface granulation in the former.

Astroschema brachiatum, Lym. (Pl. XXX. figs. 5–8).

Astroschema brachiatum, Lym., Bull. Mus. Comp. Zool., vol. vi., part 2, p. 67, pl. xvii. figs. 462–465, 1879.

Arms twenty-four times the diameter of the disk, higher than wide, with a smooth, even granulation, six to nine grains in the length of 1 mm.

(Type specimen from Station 33.) Diameter of disk 11 mm. Length of arm 270 mm. Width of arm near disk 3 mm. Height of arm at same point 3·8 mm. The granulation of the disk is, as usual, projected over the mouth angles, but there are no conspicuous grains which simulate mouth papillæ. Teeth short, blunt peg-like spines. Arms long, smooth, higher than wide, cleanly arched, and with only faint joint ridges; they are closely and uniformly covered with a smooth granulation, six to nine grains in the length of 1 mm. Disk high and arched, with well marked, somewhat elevated radial shields, running nearly to the centre. The granulation is about as on the arms. Genital openings rather short; their upper ends not reaching the level of the top of the arm. No tentacle scales (spines) on first pair of pores outside mouth slit; the next two pairs have one scale, and those beyond two, of which the lower one attains a maximum length of 2 mm., and has a rough, slightly clubbed end. Colour in alcohol, uniform chocolate-brown.

Station 33.—April 4, 1873; off Bermudas; 435 fathoms; mud.

This species stands between *Astroschema tenue* and *Astroschema lævе;* its arms are much thicker than those of the former, and much longer than those of the latter.

Astroschema rubrum, Lym. (Pl. XXXIII. figs. 1–4).

Astroschema rubrum, Lym., Bull. Mus. Comp. Zool., vol. vi., part 2, p. 68, pl. xvii. figs. 454–457, 1879.

Arms, at bases, not cleanly arched, but somewhat angular. Mouth angles puffed so as to nearly close the slits. Granulation fine, smooth, and close-set, six or seven in 1 mm. long. Tentacle scales short and scarcely club-ended.

(Type specimen from Station 310.) Diameter of disk 12 mm. Length of arm 160 mm. Width of arm near disk 3·5 mm. Height of arm 3·5 mm. Mouth angles so swollen as nearly to close the slits, and covered by a smooth granulation much obscured by skin; at the apex are small wide teeth. Arms near base as high as wide and not cleanly rounded, but inclined to be angular, and showing distinctly the outlines of arm joints; tapering uniformly; near their ends higher than wide; covered by a close-set, smooth, fine granulation, which, at bases of arms and on disk, has six or seven grains in the length of 1 mm. Disk thick, but flat on top, and rising but little above arms, covered by a thin skin, which is finely, closely, and evenly granulated. The radial shields are faintly indicated by flat ridges running to the centre. Mouth tentacles enclosed in tubes; the next have no scale; the next three or four have but one; those beyond, two, which at first are small and spiniform, and are nowhere long, the lower one attaining a maximum length of 1·4 mm. with a cylindrical form, and a rough, scarcely swollen end. Colour in alcohol, brownish-red, approaching flesh colour.

Station 310.—January 10, 1876; lat. 51° 30′ S., long. 74° 3′ W.; 400 fathoms; mud; on a Gorgonian near *Brandella*.

By its colour and smooth surface *Astroschema rubrum* may easily be mistaken for an *Ophiocreas*.

Astroschema salix, Lym. (Pl. XXII. figs. 13–15).

Astroschema salix, Lym., Bull. Mus. Comp. Zool., vol. vi., pt. 2, p. 66, pl. xvii. figs. 466–469, 1879.

Granulation fine, even, and close set; seven or eight grains in the length of 1 mm. Disk flat, with ill-distinguished radial shields. At tip of arm the lower tentacle scale takes the form of a compound hook.

(Type specimen from Station 170.) Diameter of disk 8·5 mm. Length of arm 85 mm. Width of arm near disk 3 mm. Height of arm 2·4 mm. Mouth angles covered with minute, close, smooth granulation, and bearing at their apex the usual wide spearhead-shaped teeth. Arms wide next disk, tapering rapidly for about 15 mm., and thence very gradually to their tips; covered by a fine, even, smooth, close-set granulation, seven or eight grains in the length of 1 mm. The skin, being thin, allows the outlines of the joints to show through, especially near the ends. Disk flat, scarcely rising above arms, and with a similar granulation, though rather looser on the upper surface. Radial shields scarcely to be distinguished, except at their outer ends. The first pair of pores outside mouth slit has no scale; the next six have only one; those

beyond two, whereof the inner and larger is cylindrical, with a somewhat swollen, rough end, and attains, about two-thirds out on arm, a length of 1·3 mm. At the tip the lower scale takes on the form of a flattened compound hook, with four teeth curved on its edge. Colour in alcohol, very pale brown.

Station 170.—July 14, 1874; lat. 29° 55′ S. and lat. 29° 45′ S., long. 178° 14′ W. and long. 178° 11′ W.; 520 fathoms.

Species of *Astroschema* not herein described.

Astroschema oligactes, Ltk. (Pl. XLIV. figs. 1–5).

Astroschema oligactes, Vid. Meddel., p. 16, 1856; Addit. ad Hist. part 2, p. 155, pl. v. fig. 3; Duj. & Hupé, Hist. Nat. Zooph. Echin., 1862, p. 297; Lym., Ill. Cat. Mus. Comp. Zool., No. viii., part 2, p. 26.

Asterias oligactes, Pallas, Acad. Cæs. Leop. Nova Acta, vol. ii. p. 239, pl. vi. fig. 23.

West Indies; 69 to 288 fathoms.

Astroschema arenosum, Lym., Bull. Mus. Comp. Zool., vol. v., part 9, p. 235, pl. iii. figs. 62–64, 1878.

West Indies; 805 fathoms.

Astroschema tenue, Lym., Ill. Cat. Mus. Comp. Zool., No. viii., part 2, p. 26, 1875.

Barbadoes; 100 fathoms.

Astroschema læve, Lym., Ill. Cat. Mus. Comp. Zool., No. viii., part 2, p. 26, 1875; Bull. Mus. Comp. Zool., vol. v., part 9, p. 236.

Asteromorpha lævis, Lym., Ann. Sci. Nat., p. 3, 1872.

Guadeloupe, West Indies.

Astroschema steenstrupii, Lym., Ill. Cat. Mus. Comp. Zool., No. viii., pt. 2, p. 26, 1875.

Asteroschema Rousseaui, Michelin, Notes sur l'Ile de la Réunion, Annex A, p. 6, 1863. (No proper description.)

Asteromorpha Steenstrupii, Ltk., Addit. ad Hist., part 3, p. 62, 1869; Lym., Ann. des Sci. Nat., p. 4, 1872.

Ile de la Réunion.

Astroschema sulcatum, Ljn., Dr. Goës, Oph. Öf. Kong. Akad., p. 637, 1871; Lym., Ill. Cat. Mus. Comp. Zool., No. viii., part 2, p. 26.

Anguilla, West Indies; 200 to 320 fathoms.

Astroschema intectum, Lym., Bull. Mus. Comp. Zool., vol. v., part 9, p. 235, pl. iii. figs. 59–61, 1878.

Off Havana; 175 fathoms.

Ophiocreas.

Ophiocreas, Lym., Bull. Mus. Comp. Zool., vol. i., part 10, 1869.

Disk very small, slightly arched, and divided into radiating lobes by the radial shields, and covered by a soft skin. Large strong teeth in a single vertical row. No mouth papillæ or tooth papillæ. Arms simple, very long and slender, and covered by a soft skin, which obscures the underlying parts; their under side is nearly covered by the side arm plates which bear two slightly rough cylindrical tentacle scales (or arm spines), and are continued upward by a row of narrow plates homologous with upper arm plates and covering sides and top of arm. Under arm plates small but distinct. Two small genital openings in each interbrachial space, slanting or nearly vertical and placed at the outer corners.

There are five pairs of side mouth shields, each with its mouth shield, apparently always madreporic, for each has a tube which I have not yet properly traced, but which, doubtless, is a stone canal. These shields are an Ophiuran character shared by *Astroschema*, which is only an *Ophiocreas* with a granulated skin.

Ophiocreas brings us a long step towards the true Ophiurans. An opening, somewhat inclined from the vertical, through the base of an arm and the outer corner of the disk is sketched in (Pl. XLVI. fig. 1). The integument of the arm, cut through on the side, is lifted and thrown back, while the side of the disk is wholly cut away. Above the arm bones at the base of the arm lie the double lobed spermaries (δ,δ), long, cylindrical, smooth bodies, a little curved, and tapering at each end. On the opposite side of the arm lies a corresponding pair. The genital opening (*no*) enters a spermatic pouch, or bursa, separated from the body cavity, as in Ophiurans. An extension of the lining membrane of this bursa encloses the spermatic lobes (δ,δ), which discharge into it by a pore at their inner end. I have already remarked [1] that the ovaries of this species lay in the same position, at the base of the arm. I made, however, a mistake as to the "large eggs which are about ·7 mm. long." They are not eggs but clusters of eggs, each wrapped in its membrane and comparable to those of *Astrogomphus*. The position of the genital organs, though curious, is not so exceptional as might at first appear. Among true Ophiurans the space between the digestive cavity and the sides and roof of the disk wall is crammed with these organs when gravid. In *Ophiocreas*, however, not only is the disk small, but its body cavity is limited to the perihæmal canal and to a sinus over each arm. Everywhere else the digestive cavity adheres to the body wall; therefore the genital organs are, as it were, forced into the space between the skin of the arm and the arm bones.

The dissection of a female *Ophiocreas* (an undescribed species from the "Blake" dredgings) demonstrated the homology of the genital organs with those of Ophiurans. There were two long lobes, or tubular membranous bags, on either side of the upper surface of the arm. These were in process of discharging their eggs, which takes place by the breaking up of the egg clusters and the passage of the eggs to the inner end of the

[1] Bull. Mus. Comp. Zodl., vol. vi., part 2, p. 66.

bag, where they go through a pore into the bursa, which is merely a lobed indentation of the disk wall, and is even somewhat coloured on the inside. In that respect it is not quite like the bursa of most Ophiurans, which is composed of the lining membrane, or layer, of the body wall.

The spermatozoa of *Ophiocreas œdipus* after their long immersion in alcohol, were doubtless much altered. Strongly magnified, they resembled little translucent grains of boiled sago, but showed no projection or ciliary tail.

In fig. 1, the floor of the digestive cavity (*St*, *St*) is slit to expose the spermatic pouch, so that the lower portion is separated from the upper one, which lies under the radial shield (*l*), and whose roof grows closely to the disk wall, as in Astrophytons. It also adheres, as mentioned above, to the interbrachial floor of the disk wall. Indeed, it is scarcely free at any point save a space along the top of the arm, which forms an oblong sinus.

The interior of the digestive cavity is lightly marked by radiating pleats, and there are also five pairs of strong radiating ridges, a pair over each arm, which form partial partitions.

TABLE OF SPECIES OF *Ophiocreas*.

Diameter of Disk to length of Arm.	Width of Arm to diameter of Disk.		
1 : 19	1 : 4½	Skin smooth, thin, and tight. Towards middle of arm, lower tentacle scale as long as two joints, and a little clubbed. Radial shields slender but meeting in the centre. Side arm plates stout, and at base of arm joined to well-marked under arm plates, while the upper arm plates are rudimentary.	*Ophiocreas lumbricus.*
1 : 21	1 : 6	Skin smooth, thin, and tight. Lower tentacle scale (which is shorter than in *Ophiocreas lumbricus*) enclosed in a club-ended skin bag. Radial shields feeble and not meeting in centre. But side arm plates very stout, and joined to thick upper arm plates. Under arm plates well marked.	*Ophiocreas œdipus.*
1 : 12–18	1 : 2	Skin very thick, loose, and wrinkled. Tentacle scales short and not club-ended. Side arm plates meeting below and joined to thick, crust-like, upper arm plates. Basal under arm plates well marked.	*Ophiocreas carnosus.*
1 : 13	1 : 4	Skin thick and a little puffed on arms. Tentacle scales cased in thick skin bags; and nearly as long as in *Ophiocreas lumbricus.* Mouth angles swollen so as nearly to fill the mouth, as in *Ophiocreas carnosus.*	*Ophiocreas caudatus.*
1 : 7½	1 : 4	Skin soft and moderately thick. Tentacle scales short; the lower one longer, but scarcely club-ended. Side arm plates like little mamelons. No upper arm plates.	*Ophiocreas abyssicola.*

Note.—The arm plates, mouth shields, &c., can only be seen by removing the skin.

In *Ophiocreas* and *Astroschema* the mouth gives almost no specific indications. It is by the character of the skin, or by the nature of its granulation, the thickness and length of the arms, their comparative height and breadth, and the form of the tentacle scales and of the radial shields that we get good specific marks.

Ophiocreas carnosus, Lym. (Pl. XXXI. fig. 1–4).

Ophiocreas carnosus, Lym., Bull. Mus. Comp. Zool., vol. vi., part 2, p. 63, pl. xvi. figs. 435–438, 1879.

Animal covered by a smooth, soft, wrinkled skin. Tentacle scales like rough ended but not clubbed spines, which are short even at middle of the arm.

(Type specimen from Station 308.) Diameter of disk 15 mm. Length of arm 200 mm. Width of arm near disk 7 mm.; height at the same point 6 mm. Mouth angles so fleshy and puffed as to almost entirely fill the slits; at the apex appears a small peg-like tooth; upper teeth wider and spearhead-shaped. On removing the thick, flabby skin, the usual large oblong side mouth shields are seen, joined their entire length, except without, where they diverge somewhat to give place to the little mouth shield. The side arm plates are long, narrow, and curved, and meet fully below, separating the small, irregular, transversely oblong under arm plates; at their upper end they support the tentacle scales. and unite with the belt of thin scales which represents the upper arm plate. Disk thick, rising a little above the level of the arms, covered by a very thick, soft skin, which is especially wrinkled over the side mouth shields. The same skin covers the arms, and is there loose and flabby. Radial shields narrow, rounded, thick and running quite to the centre. No tentacle scale on first arm pore; the next five have one in form of a small blunt, thick spine enveloped in a sort of skin bag; beyond there are two, the lower of which, towards middle of arm, does not exceed 3 mm., and has a rough but scarcely clubbed end. Colour in alcohol, brownish-pink, approaching flesh colour.

Station 308.—January 5, 1876; lat. 50° 10′ S., long. 74° 42′ W.; 175 fathoms; mud.

Ophiocreas caudatus, Lym. (Pl. XXXII. figs. 5–8).

Ophiocreas caudatus, Lym., Bull. Mus. Comp. Zool., vol. vi., part 2, p. 64, pl. xvi. figs. 439–442, 1879.

A large species. Arms to disk as 13 to 1. No tentacle scale on the first arm joint; then for several joints only one, small and peg like; thereafter two, which never grow very long. Skin thick.

(Type specimen from Station 232.) Diameter of disk 22 mm. Length of arm about 300 mm. Width of arm close to disk 5·5 mm. Height of arm near base 5·5 mm. Mouth angles covered with very thick skin giving a swollen look; on their sides and above the second mouth tentacle is a sort of pavement of irregular flattened grains. Twelve large thick teeth, longer than wide, with cutting edge shaped like a rounded

angle; the two lowest are smallest and are less flattened. Arm joints obscurely indicated by the arm bones, whose outlines are seen through the skin. Arms broader above than below; covered with a thick skin, which, when partly dry, presents under the microscope a minutely tuberculous surface. No tentacle scale on first arm joint; beyond this there is only one, short and peg like for some distance, sometimes as far as the thirteenth joint; after which there are two, still short, and cased in very thick bags of skin; on last third of arm the scale of the brachial side has become stout, thorny ended, and much the longer (3 mm). Disk thick and angular, covered with thick skin similar to that of the arms, and having interbrachial spaces re-enteringly curved. Radial shields high and narrow, diverging from the centre of disk to sides of the arms. The genital openings are long, extending from upper edge of disk to mouth ring. Colour in alcohol, uniform pinkish-brown.

Station 232.—May 12, 1875; off Enosima; lat. 35° 11′ N., long. 139° 28′ E.; 345 fathoms; sandy mud.

Another somewhat smaller specimen had already two tentacle scales on the fifth joint.

Ophiocreas abyssicola, Lym. (Pl. XXXII. figs. 1–4).

Ophiocreas abyssicola, Lym., Bull. Mus. Comp. Zool., vol. vi., part 2, p. 64, pl. xvii. figs. 470–473, 1879.

Arms scarcely as high as wide, about eight times the diameter of the disk. Skin quite smooth, with radial shields scarcely indicated externally. Genital openings very short, and situated near the inner interbrachial angle.

(Type specimen from Station 241.) Diameter of disk 7 mm. Length of arm about 60 mm. Width of arm close to disk 1·7 mm.; height of same 1·2 mm. Four or five short, flat grains above the second mouth tentacle, on the sides of each mouth angle. Seven stout, nearly equal teeth, shaped like a blunt spear head. On removing the skin the small, irregular, rounded mouth shield, and large, longer than broad side mouth shields, can be seen; the latter are often broken. Under arm plates rather large, rounded, as broad as long, closely soldered, and with vague outlines. Side arm plates small, rounded, and swollen, closely joined with the under arm plates. Arm joints recognisable through the skin. Arms rounded and slender, tapering very gradually to the end. Disk flat and somewhat angular, not rising above level of arms, covered with soft, moderately thick skin. Radial shields shorter and wider than in other species, separated their entire length, and very thin and flat; from the outside they are scarcely indicated, and they do not meet in the centre. Two short, stout, bluntly pointed tentacle scales, the lower one longer, and both nearly naked. Two very short genital openings, about 5 mm. long, near inner angle. When the skin is removed the genital plate and scale are seen, the plate being rounded, much longer than broad, tapering

from without inward, and having the small, peg-like scale attached near its outer end. Colour in alcohol, pale straw.

Station 241.—June 23, 1875; lat. 35° 41′ N., long. 157° 42′ E.; 2300 fathoms; red clay.

This species, well distinguished from others, is remarkable for the great depth at which it lives. The genus is usually found not far below the 100 fathom line, and 500 fathoms may be considered deep for it.

Ophiocreas œdipus, Lym. (Pl. XXXI. figs. 5–8; Pl. XLVI. fig. 1).

Ophiocreas œdipus, Lym., Bull. Mus. Comp. Zool., vol. vi., part 2, p. 65, pl. xvi. figs. 443–446, 1879.

Arms about twenty times the diameter of disk, and slender, except the base, which is swollen above, and contains the ovaries.

(Type specimen from Station 344.) Diameter of disk 12 mm. Length of arm about 250 mm. Arm much swollen for the first four or five joints next disk, where its width is 3·5 mm., then suddenly shrinking to 2 mm. with a height of 2 mm. There are numerous small, flattened grains extending along the sides of the mouth angles, above the second mouth tentacle. Eight or nine broad, flat teeth, with well rounded cutting edges, the two lowest being much narrower and peg like. On removing the skin the mouth shield is seen to be very small, a little longer than wide, with ends much rounded. Side mouth shields very large, much longer than wide, somewhat swollen, meeting within where they are narrowest. Under arm plates composed of two or more small pieces. Side arm plates swollen, meeting below, and at the base of the arm, joined to thick, narrow, ridge-like upper arm plates, which arch upward, and nearly or quite meet on the median line. Disk angular and flat, with re-entering marginal curves. Radial shields narrow and highly arched, not quite meeting in the centre, covered with thin skin, which under the microscope is seen to be set with fine points. Genital openings large and wide, occupying the whole height of the disk. Where the skin is removed the genital plate is seen to be long, very broad and thick, tapering inward; the genital scale is small and peg like. At base of arm there is only one tentacle scale; beyond there are two, the upper one very small, and spiniform, the lower one enclosed in a thick club ended skin bag.

On opening the singular swelling on the upper side of the base of the arm, it is found to be a pouch full of large egg clusters, which are about ·7 mm. long. In fact, the ovaries are in this species thus pushed beyond the disk, somewhat as in Starfishes.

Colour in alcohol, pinkish or yellowish-brown.

Station 214.—February 10, 1875; lat. 4° 33′ N., long. 127° 6′ E.; 500 fathoms globigerina ooze. Station 343.—March 27, 1876; lat. 8° 3′ S., long. 14° 27′ W.; 425 fathoms; coral. Station 344.—April 3, 1876; off Ascension Island; 420 fathoms; hard ground.

Species of *Ophiocreas* not herein described.

Ophiocreas lumbricus, Lym., Bull. Mus. Comp. Zool., vol. i., part 10, p. 347, 1869; Ill. Cat. Mus. Comp. Zool., No. vi., pl. i., figs. 19–21; Bull. Mus. Comp. Zool., vol. v., part 9, p. 236.

West Indies; 75 to 480 fathoms.

Astroceras.

Astroceras, Lym., Bull. Mus. Comp. Zool., vol. vi., part 2, 1879.

Disk and arms covered with smooth, soft skin. Disk small; its interbrachial outlines re-enteringly curved; radial shields narrow and rather high, running nearly to centre. Arms somewhat knotted by a contraction between each pair of joints. Upper arm plates divided in halves like high ribs, bearing a jointed spine at their upper ends. Side arm plates, towards middle of arm, having a long process, to which are articulated the two spine-like tentacle scales. Teeth in a single vertical row. No tooth papillæ. A clump of grains on sides of mouth angles, answering to mouth papillæ. Two vertical genital openings.

Astroceras stands next *Ophiocreas* and *Astroschema*. By its peculiar elongated side arm plates bearing spine-like, rough tentacle scales, and the large spines on the upper surface of the arm, it resembles the branching *Euryale aspera*.

Astroceras pergamena, Lym. (Pl. XXXIV. figs. 1–5).

Astroceras pergamena, Lym., Bull. Mus. Comp. Zool., vol. vi., part 2, p. 62, pl. xviii. figs. 478–480, 1879.

The smooth skin is translucent, allowing the underlying parts to be seen. The upper ends of the halves of the upper arm plates project, and bear a stout spine. Tentacle scales thick, rough ended, and nearly equal in size. On the sides of the mouth angle are elongated grains answering to mouth papillæ.

(Type specimen from Station 235.) Diameter of disk 19 mm. Length of arm about 100 mm. Width of arm at base 2 mm.; height of same 2·5 mm. High up on the sides of the mouth angles are elongated grains, irregularly arranged and answering to mouth papillæ, while at the apex is the lowest tooth, flat and shaped like a wide spearhead. Mouth shields very small, triangular, with a rounded angle inward and outer edge straight. Side mouth shields very large and swollen, narrower without, meeting broadly within; both they and the mouth shields are obscured by skin. Under arm plates small, and squarish, and occupying only a part of the length of a joint. Side arm plates nearly or quite meeting below, swollen and rounded, with a small projection to carry the two spine-like tentacle scales; further out, on the arm, this projection is much elongated, forming an articulating process. Upper arm plates represented by two rib-like ridges, which do

not meet above, but project over the upper level of the arm, and bear a large, club-like, rough spine, about 1·2 mm. long. Disk thin, and with deep constrictions in the interbrachial spaces. The smooth translucent skin allows the long and narrow radial shields to be seen; they are pointed within where they do not meet, and are separated their entire length; at their outer end they are elevated, and carry a jointed spine similar to that of the arms. The first pair of armpores has no tentacle scales; but those beyond have two, which are thick and club shaped, with rough ends, and, unlike those of *Astroschema*, are nearly equal in size, and not much elongated towards the middle of the arm, where they bear bunches of minute hooks on their ends, and have a pedunculated look, owing to the elongation of the side arm plates. Colour in alcohol, light yellowish-brown.

Station 235.—June 4, 1875; lat. 34° 7′ N., long. 138° 0′ E.; 565 fathoms; mud.

Astronyx.

Astronyx, Müll. & Tr., Syst. Ast., 1842.

Disk large, arched, well distinguished from the long slender, simple arms; and, like them, covered by a smooth, naked skin which obscures the underlying parts: the radial shields may, however, be clearly made out, as slender ridges radiating from the centre of the disk. Teeth, and tooth papillæ similar and spiniform, as are the few mouth papillæ. Side arm plates like little pads bearing hooked arm spines, and connected by a small shapeless under arm plate. Sides and top of arm quite naked, there being no upper arm plates. Two small genital openings in a depression at the inner angle of the interbrachial space.

On removing the skin this genus is found to have well-marked side mouth shields, and, in their open angle, is a minute mouth shield; one of them, larger than the rest, is the madreporic plate, which Müller and Troscher correctly located, though they did not recognise it as a mouth shield. The peristomial plate is large, transverse oval, and in a single piece. The long narrow radial shields are broken in pieces, somewhat as in Astrophyton. They are attached to very wide flat genital plates, to whose inner end is fastened a small plate which may be the genital scale.

Species of *Astronyx* not herein described.

Astronyx loveni, Müll. & Tr., Syst. Ast., p. 119, 1842.
North European Seas; Japan; 350 fathoms.

TABLE OF DOUBTFUL SPECIES.

Ophiura tongana (?), Simon's Bay, Cape of Good Hope.
Ophiopeza yoldii (?), Station 163; (gen. nov. ?) young, Station 344.
Pectinura rigida (?), Levuka Reefs, Fiji Islands.
Ophioglypha (??), Kerguelen Islands; another species ? (dry).
sp. ? Station 165; *irrorata* (? young), Station 164*a*.
sp. ? (young), Station 166; *ornata* (young), Station 216.
Ophiomastus (young), Station 142.
Ophiophyllum (damaged), Station 317.
Ophiactis (young), Station 169; (species ?), Station 190; (young), Station 191; (sp. nov., young), Straits Magellan; young (*plana* ?), Station 142.
Amphiura otteri (?), Stations 45, 50, 76, 78.
josephinæ (?), Cape Verde, St. Vincent.
antarctica (young), Prince Edward's Island; Station 166 (sp. ? too young for description); (sp. ? no disk), Arafura Sea.
depressa (?), August 7, 1874.
Amphilepis norvegica (?), Stations (33?) 45, 46.
Ophionereis schayeri (?), Arafura Sea.
dubia (?), Gomera, Canary Islands, and Amboyna.
Ophiocoma (? young), Station 163.
Ophiomastix (young), Tongatabu Reefs.
Ophiacantha near *pentacrinus* (?), Station 214; sp.? Station 164*a*; sp.? (young), Station 307.
or *Ophiomitra* (without disk), Station 146.
or *Ophiothamnus*, Station 205.
Ophiacantha, Station 308.
Ophiomitra (?), damaged, Station 70.
Ophiothamnus (? young), Station 168.
Ophiothrix lütkeni (?), Station 75.
angulata (?), Station Fernando Noronha.
ciliaris (?), Cebu.
(near *stelligera*), Samboangan.
(near *propinqua*), Samboangan.
nereidina (?), Samboangan.
virgata (? young), Station 208.
Ophiocreas œdipus (? young), Station 214, two bottles.

LIST OF OPHIURIDÆ AND ASTROPHYTIDÆ OF THE CHALLENGER EXPEDITION ARRANGED BY STATIONS.

STATION 3.—February 18, 1873; lat. 25° 45′ N., long. 20° 12′ W.; 1525 fathoms; bottom temperature 2·2° C.

Ophiacantha nodosa.
Ophiomitra chelys. Also Stations 33 (var ?) and 84.

STATION 23.—March 15, 1873; off Sombrero Island; 450 fathoms; globigerina ooze.

Ophiopyren longispinus. Also Stations 24 and 33.
Ophiozona (?) *dubia.*
Ophiomusium serratum.
validum. Also Station 24.
Ophiothamnus vicarius.
Ophiozona antillarum.

STATION 24.—March 25, 1873; off Culebra Island; 390 fathoms; mud.

Ophioglypha variabilis (young). Also Station 195.
falcifera.
Ophiopyren longispinus. Also Stations 23 and 33.
Ophioscolex tropicus.
Ophiomitra dipsacos.
Ophiozona nivea.
Ophiomusium validum. Also Station 23.

St. Thomas.

Ophiocoma echinata.
Ophiura cinerea. Also at Bahia.

STATION 33.—April 4, 1873; off Bermudas; 435 fathoms; mud.

Ophiomusium cancellatum. Also Station 236.
Ophiopyren longispinus. Also Stations 23, 24.
Ophiacantha troscheli.
Ophiomitra chelys (var ?). Also Stations 3, 84.
Astroschema brachiatum.

STATION 36.—April 23, 1873; off Bermudas; 32 fathoms; mud.

Ophiothrix angulata. Also off Bahia, Brazil.
suensonii.
Ophiomyxa flaccida. Also off Bahia.

STATION 45.—May 3, 1873; lat. 38° 34′ N., long. 72° 10′ W.; 1240 fathoms; bottom temperature 2·4° C.; mud.

Ophiacantha bidentata. Also Stations 46, 49.
Ophioglypha lepida. Also Stations 46, off Bermuda, 76, 343.
bullata. Also Stations 54, 61, 133.
Ophiomusium lymani. Also Stations 50, 76, off Tristan d'Acunha, 169, 191, 235, 296.
Amphilepis norvegica. Also Station 46.

STATION 46.—May 6, 1873; lat. 40° 17′ N., long. 66° 48′ W.; 1350 fathoms; bottom temperature 2·3° C.; mud.

Ophioglypha lepida. Also Stations 45, off Bermuda, 76, 343.
Amphilepis norvegica. Also Station 45.
Ophiacantha bidentata. Also Stations 45, 49.

STATION 49.—May 20, 1873; lat. 43° 3′ N., long. 63° 39′ W.; 83 fathoms; bottom temperature 1·8° C.; gravel, stones.

Ophiopholis aculeata.
Ophiacantha bidentata. Also Stations 45, 46.
Ophioglypha sarsii.
Astronyx loveni. Also Station 232.

STATION 50.—May 21, 1873; lat. 42° 8′ N., long. 63° 39′ W.; 1250 fathoms; bottom temperature 2·8° C.; grey ooze.

Ophiomusium lymani. Also Stations 45, 76, off Tristan d'Acunha, 169, 191,235, 296.

STATION 54.—May 27, 1873; lat. 34° 51′ N., long. 63° 59′ W.; 2650 fathoms; grey ooze.

Ophioglypha bullata. Also Stations 45, 61, 133.
Amphiura verrilli.

STATION 56.—May 29, 1873; off Bermudas; 1075 fathoms; bottom temperature 3·2° C.

Amphiura duplicata.
Ophiacantha segesta.

Off Bermuda.

Ophioglypha lepida (750 fathoms); also Stations 45, 46, 76, 343.
Ophionereis reticulata; shallow water. Also at Bahia.
Ophiocoma pumila; shallow water.

STATION 61.—June 17, 1873; lat. 34° 54′ N., long. 56° 38′ W.; 2850 fathoms; bottom temperature 1·5° C.; grey ooze.

Ophioglypha bullata. Also Stations 45, 54, 133.

STATION 73.—June 30, 1873; lat. 38° 30′ N., long. 31° 14′ W.; 1000 fathoms; bottom temperature 3·7° C.; globigerina ooze.

Ophiactis canotia.

STATION 76.—July 3, 1873; lat. 38° 11′ N., long. 27° 9′ W.; 900 fathoms; bottom temperature 4·2° C.; globigerina ooze.

Ophiomusium lymani. Also Stations 45, 50, 76, off Tristan d'Acunha, 169, 191, 235, 296.

Ophioglypha lepida. Also Stations 46, off Bermuda, 45, 343.

Ophiogeron edentulus. Also Station 175.

STATION 78.—July 10, 1873; lat. 37° 24′ N., long. 25° 13′ W.; 1000 fms.; globigerina ooze.

Ophiernus vallincola. Also Stations 146, 156.

Ophiocten hastatum. Also Stations 146, 168.

STATION 83.—July 15, 1873; lat. 33° 13′ N., long. 18° 13′ W.; 1650 fathoms; bottom temperature 2·2° C.; globigerina ooze.

Ophiomusium armigerum. Also Station 106, 299, (same sp. ?) 332.

STATION 84.—July 18, 1873; lat. 30° 38′ N., long. 18° 5′ W.; 1124 fathoms.

Ophiomitra chelys. Also Stations 3, 33 (var. ?).

STATION 87.—July 21, 1873; lat. 25° 49′ N., long. 20° 12′ W.; 1675 fathoms.

Ophiomitra carduus.

Ophiomusium pulchellum. Also Stations 122, 142.

Cape Verde, St. Vincent.

Ophiostigma africanum.

STATION 106.—August 25, 1873; lat. 1° 47′ N. long. 24° 26′ W.; 1850 fathoms; bottom temperature 1·8° C.; globigerina ooze.

Ophioglypha inornata.

Ophiomusium armigerum. Also Stations 83, 299, (same sp. ?) 332.

St. Paul's Rocks; 100 fathoms.

Ophiomyxa australis. Also Stations 161, 162, 163, 167, 172, 173, Amboyna, 201.

STATION 122.—September 10, 1873; lat. 9° 5′ to 9° 10′ S., long. 34° 49′ to 34° 53′ W.; 32, 120, 358, 400 fathoms; mud.

Ophioglypha acervata.
ljungmani.
Ophiomusium pulchellum. Also Stations 87, 142.
Ophiactis mülleri. Also off Bahia, Brazil.
Ophiosciasma attenuatum.
Ophiacantha cosmica. Also off Tristan d'Acunha, Stations 146, 147, 153, 156, 157, 158, 191, 218, 298, 299.

Bahia, Brazil; shallow.

Ophiura brevispina.
appressa.
cinerea. Also St. Thomas, West Indies.
Ophionereis reticulata. Also off Bermuda.
Ophiozona impressa.
Ophiactis mülleri. Also Station 122.
Ophiothrix angulata. Also Station 36.
Ophiomyxa flaccida. Also Station 36.
Astrophyton costosum.

STATION 128.—September 14, 1873; lat. 13° 6′ S., long. 38° 7′ W.; 1275 fathoms; mud.

Ophiocnida scabra.

STATION 133.—October 11, 1873; lat. 35° 41′ S., long. 20° 55′ W.; 1900 fathoms; bottom temperature 1·3° C.; globigerina ooze.

Ophioglypha bullata. Also Stations 45, 54, 61.

STATION 135.—October 16, 17, 18, 1873; Islands of Tristan d'Acunha; 60, 75, 100, 150, 550, 1000, 1100 fathoms; rock, shells.

Ophiomusium lymani (1100 fathoms). Also Stations 45, 50, 76, 169, 191, 235, 296.
Ophioglypha jejuna (500 fathoms). Also Station 164*a*.
inermis (500 fathoms).
Ophiactis poa (500 to 1000 fathoms).
Ophiomyces grandis (1000 fathoms).
Ophiacantha cosmica (1000 fathoms). Also Stations 122, 146, 147, 153, 156, 157, 158, 191, 218, 298, 299.

STATION 141.—Dec. 17, 1873; lat. 34° 41′ S., long 18° 36′ E.; 98 fathoms; bottom temperature 9·7° C.; sand and gravel.

Amphiura squamata. Also Station 163.
capensis.
dilatata.
Ophioglypha costata. Also Station 142.

Simon's Bay, Cape of Good Hope.

Ophiocoma scolopendrina. Also Tongatabu Reef.
Ophiactis carnea.
Amphiura incana.
Ophiothrix triglochis.
Gorgonocephalus verrucosus.

STATION 142.—December 18, 1873; lat. 35° 4′ S., long. 18° 37′ E., 150 fathoms; bottom temperature 8·3° C.; sand.

Ophiactis flexuosa. Also Station 171.
Ophioscolex dentatus.
Ophiopeza aster.
Ophiomusium pulchellum. Also Stations 87, 122.
Ophioglypha costata. Also Station 141.
Ophiothamnus remotus.
Ophiothrix aristulata. Also Stations 161 (var.), 163 (var).
Ophiomyxa vivipara. Also Stations 308, 313, 314.

STATION 143.—December 19, 1873; lat. 36° 48′ S., long. 19° 24′ E.; 1900 fathoms; bottom temperature 1·4° C.; globigerina ooze.

Ophioglypha irrorata. Also Station 164*a*, (young of this sp. ?).

STATION 145.—December 27, 1873; lat. 46° 40′ S., long. 37° 50′ E.; 310 and 150 fms.

Ophioglypha elevata.
Ophiolebes scorteus. Also Station 147.
Amphiura studeri. Also Station 151, off Marion Island, off Prince Edward's Island, Royal Sound, Balfour Bay, Kerguelen Islands.
Ophiacantha rosea. Also Stations 236, 308.

Prince Edward's Island; 85 to 150 fathoms.

Ophioconis antarctica. Also Station 150; off Marion Island.

Ophiocten amitinum. Also Kerguelen Islands; Stations 146 152, 157.

Amphiura studeri. Station 151; off Marion Island; Station 145; Royal Sound; Balfour Bay; Kerguelen Islands.

STATION 146.—December 28, 1873; lat. 46° 46′ S., long. 45° 31′ E., 1375 fathoms; bottom temperature 1·5° C.; globigerina ooze.

Ophioglypha loveni. Also Stations 147, 157, 158, (same sp,?) 160.

Ophiernus vallincola. Also Stations 78, 156, 197.

Ophiocten hastatum. Also Stations 78, 168.

amitinum. Also Stations Kerguelen Islands, Prince Edward's Islands, 146, 152, 157.

Ophiomitra sarsii.

Ophiacantha cosmica. Also Stations 122, off Tristan d' Acunha, 147, 153, 156, 157, 158, 191, 218, 298, 299.

Ophioglypha minuta. Also Station 158.

Off Marion Island; 50 to 75 fathoms.

Ophioconis antarctica. Also Station 150, and off Prince Edward's Island.

Ophioglypha hexactis. Also Kerguelen Islands.

intorta.

Amphiura studeri. Also Stations 145, 151, and off Prince Edward's Island and Kerguelen Islands.

Ophiocten sericeum.

Ophiacantha vivipara. Also Stations Kerguelen Islands, 150, 151, 313, 314, 320.

STATION 147.—December 30, 1873; lat. 46° 16′ S., long. 48° 27′ E.; 1600 fathoms; bottom temperature 0·8° C.; globigerina ooze.

Ophioglypha loveni. Also Stations 146, 157, 158, 160.

Ophiolebes scorteus. Also Station 145.

Ophiacantha cosmica. Also Stations 122, off Tristan d'Acunha, 146, 153, 156, 157, 158, 191, 218, 298, 299.

STATION 148.—January 3, 1874; lat. 46° 47′ S., long. 51° 37′ E., 210 fathoms; rock.

Astrotoma agassizii (young). Also Stations 307, 308, 309, Strait Magellan, (young) 313.

Betsy Cove, Kerguelen Islands; 20 to 25 fathoms.

Ophioglypha hexactis. Also Balfour Bay and Royal Sound, Kerguelen Islands, off Marion Islands.

Royal Sound.—Kerguelen Islands; 25 fathoms.

Ophioglypha hexactis. Also Balfour Bay, Betsy Cove, off Marion Island.

Ophioglypha deshayesi. Also Stations 150, 151 and Christmas Harbour.

Amphiura studeri. Also Stations 151, off Marion Island, 145, off Prince Edward's Island, Balfour Bay.

Ophiacantha imago. Also Christmas Harbour, Stations 150, 151.

Ophioglypha brevispina. Also Balfour Bay and off Christmas Harbour.

Ophioglypha ambigua. Also Christmas Harbour.

Ophiacantha vivipara. Also Marion Island, Christmas Harbour, Balfour Bay, Stations 150, 151, 313, 314, 320.

Off Christmas Harbour, Kerguelen Islands; 120 fathoms.

Ophioglypha ambigua. Also Royal Sound.

deshayesi. Also Stations 150, 151, Royal Sound.

brevispina. Also Royal Sound, Balfour Bay.

Ophiacantha imago. Also Royal Sound, Stations 150, 151.

vivipara. Also off Marion Island, Balfour Bay, Royal Sound, Stations 150, 151, 313, 314, 320.

Gorgonocephalus pourtalesii. Also Stations 150, 151, 307, 308, 313, 314.

Balfour Bay, Kerguelen Islands; 20 to 60 fathoms.

Ophioglypha hexactis. Also Betsy Cove, Royal Sound, off Marion Island.

brevispina. Also Royal Sound, Christmas Harbour.

Amphiura studeri. Also Stations 145, off Prince Edward's Island, 151, off Marion Island and Royal Sound.

tomentosa.

Ophicantha vivipara. Also off Marion Island, Christmas Harbour, Royal Sound, Stations 150, 151, 313, 314, 320.

STATION 150.—February 2, 1874; lat. 52° 4′ S., long. 71° 22′ E.; 150 fathoms; bottom temperature 1·8° C.; rock.

Ophioglypha deshayesi. Also Stations 151, Christmas Harbour, and Royal Sound.

Ophioconis antarctica. Also off Prince Edward's Island, off Marion Island.

Amphiura angularis.

Ophiacantha vivipara. Also off Marion Island, Christmas Harbour, Balfour Bay, Royal Sound, Stations 151, 313, 314, 320.

Ophiacantha imago. Also Christmas Harbour, Royal Sound, Station 151.

Gorgonocephalus pourtalesii (var.). Also Stations, Christmas Harbour, Kerguelen Islands, 151, 307, 308, 313, 314.

STATION 151.—February 7, 1874; off Heard Islands; 75 fathoms; mud.

Ophioglypha deshayesi. Also Stations 150, and Christmas Harbour, and Royal Sound, Kerguelen Islands.

Amphiura studeri. Also off Marion Island, Station 145, off Prince Edward's Island, Royal Sound, Balfour Bay, Kerguelen Islands.

Ophiacantha vivipara. Also off Marion Island, Christmas Harbour, Balfour Bay, and Royal Sound, Kerguelen Islands, and Stations 150, 313, 314, 320.

Ophiacantha imago. Also Christmas Harbour, Royal Sound, Kerguelen Islands, Station 150.

Gorgonocephalus pourtalesii. Also Stations Christmas Harbour, Kerguelen Islands, 150, 307, 308, 313, 314.

STATION 152.—February 11 1874; lat. 60° 52′ S., long. 80° 20′ E.; 1260 fms.; diatom ooze.

Ophiocten amitinum. Also Kerguelen Islands, Prince Edward's Island, Stations 146, 157.

STATION 153.—February 14, 1874; lat. 65° 42′ S., long. 79° 49′ E.; 1675 fathoms; mud.

Ophiacantha cosmica. Also Stations 122, off Tristan d'Acunha, 146, 147, 153, 156, 157, 158, 191, 218, 298, 299.

STATION 156.—February 26, 1874; lat. 62° 26′ S., long. 95° 44′ E.; 1975 fms.; diatom ooze.

Ophioplinthus medusa.
grisea.
Ophiernus vallincola. Also Stations 78, 146.
Ophiocten pallidum. Also Station 160.
Amphiura patula.
Ophiacantha cosmica. Also Stations 122, off Tristan d'Acunha, 146, 147, 153, 157, 158, 191, 218, 298, 299.

STATION 157.—March 3, 1874; lat. 53° 55′ S., long. 108° 35′ E.; 1950 fms.; diatom ooze.

Ophioglypha loveni. Also Stations 146, 147, 158, (same sp. ?) 160.
lienosa.
fraterna.
Ophiocymbium cavernosum.
Ophiocten amitinum. Also Kerguelen Islands, Prince Edward's Island, Stations 146, 152.
Ophiacantha cosmica. Also Stations 122, off Tristan d'Acunha, 146, 147, 153, 156, 158, 191, 218, 298, 299.

STATION 158.—March 7, 1874; lat. 50° 1′ S., long. 123° 4′ E.; 1800 fathoms; bottom temperature 0·3° C.; globigerina ooze.

Ophioglypha minuta. Also Station 146.
loveni (same sp. ?). Also Stations 146, 147, 157.
Ophiacantha cosmica. Also Stations 122, off Tristan d'Acunha, 146, 147, 153, 156, 157, 191, 218, 298, 299.

STATION 160.—March 13, 1874; lat. 42° 42′ S., long. 134° 10′ E.; 2600 fathoms; bottom temperature 0·2° C.; red clay.

Ophiocten pallidum. Also Station 156.
Ophioglypha lacazei. Also Station 299.
loveni. Also Stations 146, 147, 157, 158 (same sp. ?).

STATION 161.—April 1, 1874; off Entrance to Port Philip; 38 fathoms; sand.

Ophioglypha kinbergi. Also Stations 162, Port Jackson, and 188.
Ophiobyrsa rudis.
Ophiothrix aristulata (var.). Also Stations 142, 163 (var. ?).
Ophiomyxa australis. Also Stations 162, 163, 167, 172, St. Paul's Rocks, 173, Amboyna, 201.

STATION 162.—April 2, 1874; off East Moncœur Island, Bass Strait; 38 to 40 fathoms; sand.

Ophiocnida pilosa. Also Station 212.
Pectinura arenosa.
Ophioglypha kinbergi. Also off Port Jackson, and Stations 161, 188.
Ophionereis schayeri.
Ophiomyxa australis. Also Stations 161, 163, 167, 172, St. Paul's Rocks, 173, Amboyna, 201.

STATION 163.—April 4, 1874; lat. 36° 56′ S., long. 150° 30′ E.; trawled in 120 fathoms off Twofold Bay.

Amphiura squamata. Also Station 141.
Ophiothrix aristulata. Also Stations 142, 161 var.
Ophiomyxa australis. Also Stations 161, 162, 167, 172, St. Paul's Rocks, 173, Amboyna, 201.

STATION 163*a*.—June 3, 1874; off Port Jackson; 30 to 35 fathoms; rock.

Ophiomusium flabellum.
Ophioglypha multispina.
Ophioglypha kinbergi. Also Stations 161, 162, 188.
Amphiura constricta.
Ophiactis resiliens.
Ophiothrix cæspitosa.

STATION 164.—June 12, 1874; lat. 34° 8′ S., long. 152° 0′ E.; 950 fathoms; bottom temperature 2·2° C.; grey ooze.

Ophiacantha stimulea.
Ophiomastus tegulitius. Also Stations 165, 166, 218.

STATION 164*a*.—June 13, 1874; lat. 34° 9′ to 34° 19′ S., long. 151° 55′ to 151° 31′ E. 400 fathoms. Also 1200 fathoms; grey ooze.

Ophioglypha palliata.
jejuna. Also Station 135.
Ophiactis hirta (400 fathoms).

STATION 165.—June 17, 1874; lat. 34° 50′ S., long. 155° 28′ E.; 2600 fathoms; bottom temperature 0·6° C.; red clay.

Ophiomastus tegulitius. Also Stations 164*a*, 166, 218.
Ophioglypha ornata. Also Station 216.

STATION 166.—June 23, 1874; lat. 38° 50′ S., long. 169° 20′ E., 275 fathoms; bottom temperature 10·0° C.; globigerina ooze.

Ophiomastus tegulitius. Also Stations 164*a*, 165, 218.

STATION 167*a*.—June 27, 1874; Queen Charlotte Sound, New Zealand; 10 fathoms; mud.

Pectinura maculata.

STATION 168.—July 8, 1874; lat. 40° 28′ S., long. 177° 43′ E.; 1100 fathoms; bottom temperature 2·0° C.; grey ooze.

Ophiocten hastatum. Also Stations 78, 146.
Ophiozona stellata. Also Station 169.

STATION 169.—July 10, 1874; lat. 37° 34′ S., long. 179° 22′ E.; 700 fathoms; bottom temperature 4·2° C.; grey ooze.

Ophioglypha rugosa.
Ophiomusium lymani. Also Stations 45 50, 76, off Tristan d'Acunha, 191, 235, 296.
Ophiozona stellata. Also Station 168.
Amphiura lanceolata.

STATION 170.—July 14, 1874; lat. 29° 55′ S., long. 178° 14′ W.; 520 fathoms; bottom temperature 6·0° C.

Ophiactis cuspidata. Also Station 171.
Ophiacantha cornuta. Also Station 171.

STATION 170*a*.—July 14, 1874; lat. 29° 45′ S., long. 178° 11′ W.; 630 fathoms; bottom temperature 4·0° C.; rock.

Ophiomitra plicata. Also Stations 205, 214.
Ophioceramis (?) *clausa.* Also Station 171.
(?) *obstricta.* Also Station 192.
Astroschema salix.
horridum.

STATION 171.—July 15, 1874; lat. 28° 33′ S., long. 177° 50′ W.; 600 fathoms; bottom temperature 4·0° C.

Ophiomusium scalare.
Ophiophyllum petilum. Also Stations 174.
Ophiochiton lentus.

Ophioceramis (?) *clausa.* Also Station 170.
Ophiactis flexuosa. Also Station 142.
cuspidata. Also Station 170.
nama. Also Station 174.
Amphiura canescens.
argentea.
Ophiacantha vepratica.
cornuta. Also Station 170.

STATION 172.—July 22, 1874; off Nukualofa, Tongatabu; 240 fathoms; coral.

Ophioconis pulverulenta.
Ophiopyrgus wyville-thomsoni.
Ophiomyxa australis. Also Stations 161, 162, 163, St. Paul's Rocks, 167, Amboyna, 173, 201.

Tongatabu Reefs.

Ophiocoma scolopendrina. Also Simon's Bay, Cape Good Hope, Levuka Reefs, Fiji.
Ophiothrix longipeda. Also Stations 186, Ternate Shore (August 7, 1874), 188. Amboyna and Samboangan.
trilineata.
propinqua. Also Levuka Reefs, Fiji.

STATION 173.—July 24, 1874; lat. 19° 10′ S., 179° 40′ E., 315 to 310 fathoms; coral.

Ophiozona insularia.
Ophiopyren brevispinus.
Ophiomyxa australis. Also Stations 161, St. Paul's Rocks, 162, 163, 167, Amboyna, 172, 201.

Levuka Reefs, Fiji.

Pectinura gorgonia.
Ophiocoma scolopendrina. Also Simon's Bay, Cape Good Hope, Tongatabu Reefs.
Ophiomastix mixta.
Ophiochæta setosa.
Ophiothrix propinqua. Also Tongatabu, Samboangan, (same sp. ?)

STATION 174.—August 3, 1874; lat. 19° 10′ S., long. 178° 10′ E., 210 to 600 fathoms; bottom temperature 3·7° C.; globigerina ooze.

Ophiophyllum petilum. Also Station 171.

Amphiura bellis (var ?). Also Stations 232, 236.
Ophiactis nama. Also Station 171.

August 7, 1874; shallow.

Ophionereis dubia.
Ophiothrix martensi.
longipeda. Also Stations 186, Ternate Shore, 188, Tongatabu, Amboyna, (same sp. ?) Samboangan.
Ophiothrix stelligera. Also Stations 186, Samboangan (same sp. ?). Arafura Sea.

STATION 175.—August 12, 1874; lat. 19° 2′ S., long. 177° 10′ E.; 1350 fathoms; bottom temperature 1·8° C.; red clay.

Ophiogeron edentulus. Also Station 76.
Ophiacantha placentigera.
Ophiambix aculeatus.
Ophiohelus pellucidus.

STATION 176.*—August 15, 1874; lat. 18° 30′ S., long. 173° 52′ E.; 1450 fathoms; bottom temperature 2·0° C.; red clay.

Ophioglypha undata.

STATION 177.—August 18, 1874, lat. 16° 45′ S., long. 168° 5′ E., 63 to 125 fathoms.

Ophiothrix purpurea. This shallow water species was labelled Station 176, evidently an error. Also Banda.

STATION 186.—September 8, 1874; lat. 10° 30′ S., long. 142° 18′ E., 8 fathoms; coral sand.

Ophiolepis cincta. Also Samboangan.
annulosa. Also off Ternate Shore.
Ophiothrix stelligera. Also August 7, 1874, Samboangan, Arafura Sea (same sp. ?).
Ophiothrix longipeda. Also Ternate Shore (August 7, 1874), Station 188, Tongatabu (same sp. ?), Amboyna (same sp. ?), Samboangan.
Euryale aspera.
Arafura Sea.
Ophiothrix stelligera. Also August 7, 1874. Station 186, Samboangan (same sp. ?),

* There must be an error about the locality of this specimen, as there was no dredging at this station.—J. M.

STATION 187.—September 9, 1874 ; lat. 10° 36′ S., long. 141° 55′ E. ; 6 fms. ; coral sand.

Ophiomaza cacaotica.

STATION 188.—September 10, 1874 ; lat. 9° 59′ S., long. 139° 42′ E. ; 28 fathoms; mud.

Ophioglypha kinbergi. Also Stations 161, 162, off Port Jackson.
Amphiura maxima.
Ophiothrix longipeda. Also Station 186, Ternate Shore (August 7, 1874), Samboangan.
exigua (var ?). Also Station 208.

STATION 190.—September 12, 1874 ; lat. 8° 56′ S., long. 136° 5′ E. ; 49 fathoms ; bottom temperature 23·9° C. ; mud.

Ophiacantha discoidea.
Ophiothrix melanosticta.
Astrophyton exiguum.

STATION 191.—September 23, 1874 ; lat. 5° 41′ S., long. 134° 4′ E. ; 800 fathoms ; bottom temperature 3·9° C. ; mud.

Ophiomusium lymani. Also Stations 45, 59, 76, off Tristan d'Acunha, 169, 235, 296.
Ophiochiton fastigatus. Also Station 232.
Pectinura heros.
Amphiura concolor. Also Station 195.
Ophiacantha cosmica. Also Stations 122, off Tristan d'Acunha, 146, 147, 153, 156, 157, 158, 218, 298, 299.

STATION 192.—September 26, 1874 ; lat. 5° 42′ S., long. 132° 25′ E. ; 129 fathoms ; mud.

Ophiomusium laqueatum.
lütkeni.
Ophioglypha solida.
Ophiacantha valenciennesi.
Ophioceramis (?) *obstricta.* Also Station 170.
Ophiocamax vitrea. Also Stations 201, 204, 219.
Ophiothrix berberis. Also Cebu, Philippines.
Astroschema tumidum.
Astroclon propugnatoris.

STATION 194.—September 29, 1874; lat. 4° 33′ S., long. 129° 58′ E.; 200 fathoms; volcanic detritus.

Astrotoma murrayi.

Banda.

Ophiothrix purpurea. Also Station 177 (?).

STATION 195.—October 5, 1874; lat. 4° 21′ S., long. 129° 7′ E.; 1425 fathoms; bottom temperature 3·0° C.; grey ooze.

Ophioglypha variabilis. Also Station 24 (same sp. ?).
Amphiura concolor. Also Station 191.

Ternate Shore.

Ophiocoma pica.
Ophiolepis annulosa. Also Station 186.
Ophiothrix longipeda. Also Station 186 (August 7, 1874), 188, Samboangan.

STATION 198.—October 20, 1874; lat. 2° 55′ N., long. 124° 53′ E.; 2150 fathoms; bottom temperature 3·7° C.; red clay.

Amphilepis papyracea.

Amboyna; 100 fathoms.

Ophiomusium simplex.
Ophiomyxa australis. Also Stations St. Paul's Rocks, 161, 162, 163, 167, 172, 173, 201.

STATION 201.—October 26, 1874; lat. 7° 3′ N., long. 121° 48′ E.; 82 to 102 fathoms; stones and gravel.

Ophiacantha granulosa.
Ophiocamax vitrea. Also Station 192, 204, 219.
Ophiomyxa australis. Also Stations 161, St. Paul's Rocks, 162, Amboyna, 163, 167, 172, 173.

STATION 203.—October 31, 1874; lat. 11° 7′ N., long. 123° 7′ E.; 12 to 20 fathoms; mud.

Ophiogymna elegans.
Euryale aspera. Also Station 186.

STATION 204.—November 2, 1874; lat. 12° 43′ N., long. 122° 10′ E.; 100 to 115 fms.; mud.

Ophiocamax vitrea. Also Station 192, 201, 219.
Ophiothrix capillaris. Also Cebu, Philippines.

STATION 205.—November 13, 1874; lat. 16° 42′ N., long. 119° 22′ E.; 1050 fathoms; bottom temperature 2·4° C.; grey ooze.

Ophioglypha radiata.
Ophiomitra plicata. Also Stations 170, 214.

STATION 207.—January 16, 1875; lat. 12° 21′ N., long. 122° 15′ E.; 700 fathoms; bottom temperature 10·8° C.; mud.

Ophiacantha abnormis. Also Station 210.

STATION 208.—January 17, 1875; lat. 11° 37′ N., long. 123° 32′ E.; 18 fathoms; mud.

Ophiactis savignyi. Also Samboangan.
Ophiothrix striolata. Also Samboangan.
exigua. Also Station 188 (var. ?).
pusilla.
Pectinura stellata.

Cebu Reef, Philippines.

Ophiomastix caryophyllata.
Ophiocoma scolopendrina. Also Cape of Good Hope, Tongatabu Reefs, Samboangan, Philippines, Fiji, Papeete Reefs.

STATION 209.—January 22, 1875; lat. 10° 10′ N., long. 123° 55′ E.; 95 to 100 fms.; mud.

Ophiacantha longidens.
Ophiocamax vitrea. Also Stations 192, 201, 204, 219.
Ophiothrix capillaris. Also Station 204.
berberis. Also Station 192.

STATION 210.—January 25, 1875; lat. 9° 26′ N., long. 123° 45′ E.; 375 fathoms; bottom temperature 12·2° C.; mud.

Ophiacantha tuberculosa.
abnormis. Also Station 207.

STATION 212.—January 30, 1875; lat. 6° 55′ N., long. 122° 15′ E.; 10 to 14 to 20 fathoms; sand.

Ophiocnida pilosa. Also Station 162.
Astrophyton exiguum. Also Station 190.

Samboangan, Philippines.

Ophiocoma erinaceus.
scolopendrina. Also Cebu Reefs, Cape of Good Hope, Tongatabu Reefs, Fiji, Papeete Reefs.

Ophiolepis cincta. Also Station 186.
Ophiactis savignyi. Also Station 208.
Ophiothrix striolata. Also Station 208.
Ophiothrix stelligera. Also Stations 186, (August 7, 1874) Arafura Sea (same sp.?).
Ophiothrix longipeda. Also Stations 186, Ternate Shore (August 7, 1874), 188, Tongatabu (same sp. ?), Amboyna (same sp. ?).

STATION 214.—Feb. 10, 1875; lat. 4° 33′ N., long. 127° 6′ E.; 500 fms.; bottom temperature 5·3° C.; globigerina ooze.

Amphiura glabra.
Ophiozona depressa.
Ophiacantha levispina.
Ophiomitra plicata. Also Stations 170, 205.
Ophiocreas œdipus. Also Stations 343, 344.
Ophiactis pectorale.

STATION 216.—Feb. 16, 1875; lat. 2° 56′ N., long. 134° 11′ E.; 2000 fms.; bottom temperature 0·9° C.; globigerina ooze.

Ophioglypha ornata.

STATION 218.—March 1, 1875; lat. 2° 33′ S., long. 144 °4′ E.; 1070 fms.; bottom temperature 2·1° C.; globigerina ooze.

Ophioglypha æqualis.
Ophiacantha cosmica. Also Stations 122, off Tristan d'Acunha, 146, 147, 153, 156, 157, 158, 191, 298, 299.
Ophiotrochus panniculus.
Ophiomastus tegulitius. Also Stations 164*a*, 165, 166.

STATION 219.—March 10, 1875; lat. 1° 50′ S., long. 146° 42′ E.; 150 fathoms; mud.

Ophiopeza æqualis.
Ophiomusium lunare
Ophiacantha serrata.
Ophiocamax vitrea. Also Stations 192, 201, 204, Cebu Philippines.

STATION 224.—Mar. 21, 1875; lat. 7° 45′ N., long. 144 °20′ E.; 1850 fms.; bottom temperature 1·3° C.; globigerina ooze.

Ophiomusium corticosum.
Ophioglypha undulata.

STATION 232.—May 12, 1875; lat. 35° 11′ N., long. 139° 28′ E.; 345 fms.; bottom temperature 5·0° C.; sandy mud.

Ophioglypha ponderosa.
imbecillis.
flagellata.
Ophiochiton fastigatus. Also Station 191.
Amphiura bellis. Also Stations 174 (var ?), 236.
glauca. Also Station 236.
Ophiomitra normani. Also Stations 235, 236.
Ophiocreas caudatus.
Astronyx loveni. Also Station 49.

STATION 233*b*.—May 26, 1875; lat. 34° 20′ N., long. 133° 35′ E.; 15 fathoms; mud.

Ophioglypha sinensis. Also off Yokohama, Japan.

STATION 235.—June 4, 1875; lat. 34° 7′ N., long. 138° 0′ E.; 565 fathoms; bottom temperature 3·3° C.; mud.

Ophiomusium lymani. Also Stations 45, 50, 76, off Tristan d'Acunha, 169, 191, 296.
Ophioglypha lapidaria.
Amphiura acacia.
Ophiomitra normani. Also Stations 232, 236.
Ophiomyces spathifer.
Ophiopholis japonica. Also Station 236.
Astroceras pergamena.

STATION 236.—June 5, 1875; lat. 34° 58′ N., long. 139° 30′ E.; 420 to 775 fathoms; bottom temperature 2·8° C.; mud.

Ophiomusium cancellatum. Also Station 33 (same sp. ?).
Ophioglypha albata.
Ophiopholis japonica. Also Station 235.
Amphiura iris.
glauca. Also Station 232.
bellis. Also Stations 174 (var ?), 232.
Ophiacantha rosea. Also Stations 145, 308.
Ophiomitra normani. Also Stations 232, 235.

Off Yokohama, Japan.

Ophioglypha sinensis. Also Station 233*b*

STATION 237.—June 17, 1875; lat. 34° 37′ N., long. 140° 32′ E.; 1875 fathoms; bottom temperature 2·8° C.; mud.

Ophioglypha orbiculata.
sculptilis.
Ophiomusium granosum.
Amphilepis tenuis.

STATION 241.—June 23, 1875; lat. 35° 41′ N., long. 157° 42′ E.; 2300 fathoms; bottom temperature 1·1° C.; red clay.

Amphiura cernua.
Ophioglypha convexa. Also Stations 246, 346.
Ophiocreas abyssicola.

STATION 246.—July 2, 1875; lat. 36° 10′ N., long. 178° 0′ E.; 2050 fathoms; bottom temperature 1·3° C.; grey ooze.

Ophioglypha convexa. Also Stations 241, 346.

Honolulu Reefs.

Ophionereis porrecta.
Ophiocoma erinaceus. Also Samboangan Bank.

STATION 276.—September 16, 1875; lat. 13° 28′ S., long. 149° 30′ W.; 2350 fms.; bottom temperature 1·0° C.; red clay.

Ophiochytra epigrus.

STATION 296.—November 9, 1875; lat. 38° 6′ S., long. 88° 2′ W.; 1825 fathoms; bottom temperature 1·2 C.; red clay.

Ophiotholia supplicans.
Ophiomusium lymani. Also Stations 45, 50, 76, off Tristan d'Acunha, 169, 191, 235.

STATION 298.—November 17, 1875; lat. 34° 7′ S., long. 73° 56′ W.; 2225 fms.; bottom temperature 1·3° C.; grey mud.

Ophiacantha sentosa.
cosmica. Also Stations 122, off Tristan d'Acunha, 146, 147, 153, 156, 157, 158, 191, 218, 298, 299.

STATION 299.—December 14, 1875; lat. 33° 31′ S., long. 74° 43′ W.; 2160 fathoms; bottom temperature 1·1° C.; grey mud.

Ophioglypha lacazei. Also Station 160.
Ophiomusium armigerum. Also Stations 83, 106, (same sp ?) 332.
Amphilepis patens.
Ophiacantha cosmica. Also Stations 122, off Tristan d'Acunha, 146, 147, 153, 156, 157, 158, 191, 218, 298.

STATION 304.—December 31, 1875; lat. 46° 53′ S., long. 75° 11′ W.; 45 fathoms; sand.

Ophioglypha lymani. Also Stations 305, 307, 308, 309, 311, 313.

STATION 305.—January 1, 1876; lat. 47° 48′ S., long. 74° 48′ W.; 120 fathoms; mud.

Ophioglypha lymani. Also Stations 304, 307, 308, 309, 311, 313.

STATION 307.—January 4, 1876; lat. 49° 24′ S., long. 74° 23′ W.; 147 fathoms; bottom temperature 7·6° C.; mud.

Ophioglypha lymani. Also Stations 304, 305, 308, 309, 311, 313.
Ophiolebes vestitus. Also Stations 308, 310.
Astrotoma agassizii. Also Stations 148, 307, 308, Strait Magellan, 309, 313.
Gorgonocephalus pourtalesii. Also Stations Christmas Harbour, Kerguelen Islands, 150, 151, 308, 313, 314.

STATION 308.—January 5, 1876; lat. 50° 10′ S., long. 74° 42′ W.; 175 fathoms; mud.

Ophiolebes vestitus. Also Stations 307, 310.
Ophiactis asperula. Also Stations 311, 312, 315.
Ophioglypha lymani. Also Stations 304, 305, 307, 309, 311, 313.
Ophiacantha rosea. Also Stations 145, 236.
Ophiomyxa vivipara. Also Stations 142, 313, 314.
Ophiocreas carnosus.
Astrotoma agassizii. Also Stations 148, 307, 309, Strait Magellan, 313.
Gorgonocephalus pourtalesii. Also Stations Christmas Harbour, Kerguelen Islands, 150, 151, 307, 313, 314.

STATION 309.—January 8, 1876; lat. 50° 56′ S., long. 74° 15′ W.; 40 to 140 fathoms; mud.

Ophioglypha lymani. Also Stations 304, 305, 307, 308, 311, 313.
Astrotoma agassizii. Also Stations 148, 307, 308, Strait Magellan, 313.

STATION 310.—January 10, 1876; lat. 51° 30′ S., long. 74° 3′ W.; 400 fathoms; bottom temperature 7·9° C.; mud.

Ophiolebes vestitus. Also Stations 307, 308.

Astroschema rubrum.

STATION 311.—January 11, 1876; lat. 52° 50′ S., long. 73° 53′ W.; 245 fathoms; bottom temperature 7·7° C.; mud.

Ophioglypha lymani. Also Stations 304, 305, 307, 308, 309, 313.

Ophiactis asperula. Also Stations 308, 312, 315.

STATION 312.—January 13, 1876; lat. 53° 38′ S., long. 70° 56′ W.; 10 to 15 fms.; mud.

Ophiactis asperula. Also Stations 308, 311, 315.

STATION 313.—January 20, 1876; lat. 52° 20′ S., long. 68° 0′ W.; 55 fathoms; bottom temperature 8·8° C.; sand.

Ophioglypha lymani. Also Stations 304, 305, 307, 308, 309, 311.

Ophiacantha vivipara. Also Stations, off Marion Islands, Christmas Harbour, Balfour Bay and Royal Sound, Kerguelen Islands, 150, 151, 314, 315, 320.

Ophiomyxa vivipara. Also Stations 142, 308, 314.

Astrotoma agassizii. Also Stations 148, 307, 308, 309, Straits Magellan.

Gorgonocephalus pourtalesii. Also Stations Christmas Harbour, Kerguelen Islands, 150, 151, 307, 308, 314.

Straits of Magellan.

Astrotoma agassizii. Also Stations 148, 307, 308, 309, 313.

STATION 314.—January 21, 1876; lat. 51° 36′ S., long. 65° 40′ W.; 70 fathoms; bottom temperature 7·8° C.; sand.

Ophiacantha vivipara. Also off Marion Island, Christmas Harbour, Royal Sound, and Balfour Bay, Kerguelen Islands, Stations 150, 151, 313, 320.

Ophiomyxa vivipara. Also Stations 142, 308, 313.

Gorgonocephalus pourtalesii. Also Stations Christmas Harbour, Kerguelen Islands, 150, 151, 307, 313.

STATION 315.—Jan. 26, 1876; lat. 51° 40′ S., long. 57° 50′ W.; 5 to 12 fms.; sand, gravel.

Ophiactis asperula. Also Stations 308, 311, 312.

Ophiacantha vivipara. Also Stations off Marion Island, Christmas Harbour, Balfour Bay, and Royal Sound, Kerguelen Islands, 150, 151, 313, 314, 320.

STATION 317.—February 8, 1876; lat. 48° 37′ S., long. 55° 17′ W.; 1035 fms.; bottom temperature 1·7° C.; hard ground.
Ophioglypha meridionalis. Also Station 320.

STATION 320.—February 14, 1876; lat. 37° 17′ S., long. 53° 52′ W.; 600 fms.; bottom temperature 2·7° C.; hard ground.
Ophioglypha confragosa.
meridionalis. Also Station 317.
Ophiochondrus stelliger.
Ophiacantha vivipara. Also Stations, off Marion Islands, Christmas Harbour, Balfour Bay, and Royal Sound, Kerguelen Islands, 150, 151, 313, 314, 315.

STATION 323.—February 28, 1876; lat. 35° 39′ S., long. 50° 47′ W.; 1900 fms.; bottom temperature 0·0° C.; grey mud.
Ophiomusium archaster.

STATION 325.—March 2, 1876; lat. 36° 44′ S., long. 46° 16′ W.; 2650 fms.; bottom temperature 0·4° C.; grey mud.
Ophiocten umbraticum.
Amphiura dalea.

STATION 332.—March 10, 1876; lat. 37° 29′ S., long. 27° 31′ W.; 2200 fms.; bottom temperature 0·4° C.; globigerina ooze.
Ophiomusium armigerum. Also Stations 83, 106, 299.

STATION 343.—March 27, 1876; lat. 8° 3′ S., long. 14° 27′ W.; 425 fathoms; bottom temperature 4·5° C.; coral.
Ophioglypha lepida. Also Stations 45, 46, off Bermuda, 76.
Ophiocreas œdipus. Also Stations 214 (same sp.?), 344.

STATION 344.—April 3, 1876; off Ascension Island; 420 fathoms; hard ground.
Ophiacantha cuspidata.
Ophiocreas œdipus. Also Stations 214 (same sp.?), 343.

STATION 346.—April 6, 1876; lat. 2° 42′ S., long. 14° 41′ W.; 2350 fms.; bottom temperature 0·4° C.; globigerina ooze.
Ophioglypha convexa. Also Stations 241, 246.

The data of the foregoing table; combined with facts previously known, give some idea of the geographical distribution of the two families. It appears that, although deep species are more inclined to extensive wanderings than those of the shallows, yet, on the

whole, they offer similar differences. Among littoral forms there are those that are found all over the Great Ocean from the Sandwich Islands to the East Coast of Africa and even south to the Cape of Good Hope. One species, *Amphiura squamata*, is found in the North and South Atlantic, at the Cape of Good Hope, and in Australia. Others, again, are considerably restricted; for example, the abundant fauna of the Caribbean Sea which reaches only Brazil on the south and the Carolinas on the north. *Ophiacantha vivipara* and *Gorgonocephalus pourtalesii*, going to 140 and 600 fathoms, are remarkable for their extension in longitude, being found from the Kerguelen Islands on the west to the east coast of South America. Coming to the species more strictly of deep water, there is *Ophiomusium lymani*, which occurs well up in the North Atlantic, in the extreme South Atlantic, near New Zealand, off Japan, and off the south-west coast of South America. *Ophiacantha cosmica* is found off the Brazil Coast, between the Cape of Good Hope and the Kerguelen Islands, off the south-west coast of South America, and at points intermediate. But there are not wanting deep-water species which appear to be quite restricted in their habitat. Such are *Pectinura heros*, *Ophiomusium validum*, and *Astroschema arenosum*; the first living near the Celebes, the last two in the Caribbean Sea.

It is certain that while species differ much in the extent of their migrations, there are certain bottoms where they decline to live at all. Thus in all the deep water, from the centre of the North Pacific (Station 246) to near the south-west coast of South America, there was found but a single Ophiuran. Near the masses of land, whether insular or continental, there are always spots, both shallow and deep, that carry abundant faunæ.

BATHYMETRICAL TABLES.

TABLE I.—Species appearing above 30 fathoms.

This table embraces all known living Ophiuridæ and Astrophytidæ. A Roman numeral opposite a species shows that it is found also in one of the other tables thus indicated.

Ophiura brevicauda, II.	*Ophiura wahlbergii*.
guttata.	*rubicunda*.
brevispina, II.	*panamensis*.
holmesii.	*squamosissima*.
daniana.	*teres*.
januarii.	*appressa*.
variegata.	*tongana*.
lævis.	*Ophiopeza fallax*.
cinerea, II.	*yoldii*.

Pectinura infernalis.
gorgonia.
marmorata.
maculata.
septemspinosa.
rigida.
stellata.
spinosa.
Ophiolepis cincta.
paucispina.
annulosa.
elegans.
variegata.
Ophioplocus imbricatus.
esmarkii.
Ophiozona impressa.
pacifica.
Ophioceramis albida, II.
Ophioglypha ciliata, II.
sinensis.
kinbergii, II.
albida, II., III.
sarsii, II., III.
arctica, II.
lütkeni, II.
affinis, II., III.
robusta, II.
sladeni.
striata.
sculpta.
hexactis, II.
brevispina, II.
ambigua, II.
nodosa, II.
stuwitzii.
Ophiocten sericeum, II.
Ophiomusium flabellum, II.
Ophioconis forbesii, II.
brevispina.
Ophiochæta setosa.
Ophiopholis aculeata, II., III.
kennerlyi.
caryi.
mirabilis.
Ophiactis savignyi.
affinis.
mulleri, II., III.
resiliens, II.
loricata, II.
plana, II.
virens.
simplex.
arenosa.
kröyeri.
nigrescens.
maculosa.
carnea.
Amphiura maxima.
verticellata.
candida.
studeri, II., III.
incana.
magellanica.
grandisquama, II., III.
stimpsonii, II.
duncani.
constricta.
sundevalli, II.
tomentosa, II.
flexuosa.
latispina.
kinbergi.
atlantica.
perplexa.
sarsii, II.-IV.
filiformis, II.
squamata, II.
torelli.

Amphiura pugetana.
violacea.
patagonica.
microdiscus.
puntarenæ.
limbata.
geminata.
kochii.
subtilis.
gracillima.
riisei.
grisea.
antarctica.
planispina.
barbaræ.
atra.
lütkeni.
urtica.
occidentalis.
chilensis.
fissa.
örstedii.
repens.
pulchella, II.
securigera.
lævis.
hastata.
integra.
andreæ.
gibbosa.
abdita.
lobata.
Ophionema intricata.
Ophionephthys limicola.
phalerata.
Ophiocnida brachiata.
scabriuscula.
hispida.
filogranea.
Ophiocnida loveni.
echinata.
pilosa II.
putnami.
Ophiopus arcticus, III.
Hemipholis cordifera.
gracilis.
Ophiophragmus wurdemani.
marginatus.
Ophiopsila aranea, II.
annulosa.
riisei.
fulva, II., III.
Ophionereis dubia.
reticulata.
annulata, II.
schayeri.
albomaculata.
porrecta, II.
Ophiostigma isacanthum, II.
tenue.
formosa.
africanum.
Ophiocoma scolopendrina.
erinaceus.
wendtii.
schœnleinii.
echinata.
riisei.
æthiops.
brevipes.
squamata.
pica.
nigra.
canaliculata.
valenciæ.
pumila.
alexandri.
papillosa.

Ophiarachna incrassata.
affinis.
armata.
Ophiarthrum elegans.
pictum.
Ophiomastix annulosa.
caryophyllata.
venosa.
mixta.
asperula.
janualis.
flaccida.
Ophiopteris antipodum.
Ophiacantha vivipara, II.–IV.
imago, II.
abyssicola, II., III.
bidentata, II.–V.
Ophiomitra valida, II.
Ophiothamnus vicarius, II.
Ophiothrix fragilis, II.
echinata.
pentaphyllum.
alopecurus.
lusitanica.
triglochis.
cæspitosa.
roseo-cærulans.
quinquemaculata.
fumaria.
angulata, II.
örstedii.
spiculata.
koreana.
magnifica.
rudis.
dumosa.
lineata.
demessa.
parasita.
Ophiothrix hirsuta.
longipeda.
punctolimbata.
rotata.
planulata.
pusilla.
exigua.
ciliaris.
stelligera.
carinata.
aspidota.
triloba.
propinqua.
nereidina.
galateæ.
cataphracta.
cærulea.
spongicola.
martensi.
virgata.
trilineata.
melanosticta.
striolata, II.
elegans.
comata (?).
suensonii, II.
purpurea.
capensis.
plana.
Ophiogymna elegans.
Ophiocnemis marmorata.
Ophiomaza cacaotica.
obscura.
Ophiothela mirabilis.
danæ.
tigris.
dividua.
isidicola.
verrilli.

Ophiopsammium semperi.
Ophioblenna antillensis.
Ophiomyxa pentagona.
flaccida, II., III.
australis, II., III.
Astrophyton costosum.
spinosum.
nudum.
clavatum.
panamense.
exiguum.
Gorgonocephalus arborescens.
lamarckii.[1]
Gorgonocephalus agassizii.
linckii.[1]
caryi.
stimpsonii.
cacaoticus.
verrucosus.
australis.
chilensis.
Euryale aspera.
Trichaster palmiferus.
elegans.
Astroschema lævе (?).
steenstrupii (?).

Number of Species in Table I., 278.

TABLE II.—Species appearing below 30 and above 150 fathoms.

Ophiura brevicauda, I.
brevispina, I.
cinerea, I.
elaps (?).
Ophiopeza aster.
æqualis.
Pectinura vestita.
verrucosa.
arenosa.
Ophiopæpale goesiana, III.
Ophiogona lævigata.
Ophiolepis carinata.
Ophiozona nivea, III.
Ophioceramis januarii.
albida, I.
obstricta.
Ophiothyreus goësi, III.
Ophioglypha ciliata, I.
kinbergii, I.
albida, I.–III.
acervata, III.
Ophioglypha carnea, III.
sarsii, I.–III.
arctica, I.
lütkeni, I.
affinis, I.–III.
robusta, I.
forbesii.
multispina.
hexactis, I.
lymani, III.
costata.
brevispina, I.
ambigua, I.
nodosa, I.
solida.
deshayesi.
intorta.
Ophiocten sericeum, I.
abyssicolum, III.
Ophiomusium laqueatum.
acuferum, III.

[1] *Gorgonocephalus lamarckii* and *linckii*, doubtless, are found much deeper, but I have not accurate data on this point.

Ophiomusium lütkeni.
simplex.
lunare.
testudo, III.
flabellum, I.
Ophiolipus agassizii.
Ophioconis forbesii, I.
antarctica.
Ophiopholis aculeata, I., III.
Ophiactis mulleri, var., *quinqueradia* I., III.
resiliens, I.
balli.
asperula, III.
loricata, I.
lymani.
plana, I.
flexuosa, III., IV.
Amphiura crassipes.
chiajei.
eugeniæ.
studeri, I., III.
palmeri.
capensis.
grandisquama, I., III.
stimpsoni, I.
sundevalli, I.
tomentosa, I.
angularis.
dilatata.
sarsii, I., III., IV.
filiformis, I.
borealis, III.
squamata, I.
tenuispina, III.
coreæ.
duplicata, III.–V.
pulchella, I.
Amphilepis norvegica, III.–V.
Ophiocnida, abnormis.
olivacea.
pilosa, I.
Hemipholis microdiscus.
Ophiophragmus septus.
Ophiopsila aranea, I.
riisei.
fulva, I., III.
Ophionereis reticulata.
annulata, I.
porrecta, I.
Ophioplax ljungmani.
Ophiostigma isacanthum, I.
Ophiocoma raschii.
Ophiacantha granulosa.
valenciennesi.
spectabilis.
rosea, III., IV.
vivipara, I., III., IV.
bidentata, I., III., IV., V.
imago, I.
hirsuta, III.
troscheli, III.
setosa.
longidens.
dallasii.
stellata.
discoidea.
pentacrinus, III., IV.
abyssicola, I. III.
serrata.
Ophiolebes humilis, III.
vestitus, III.
Ophiomitra valida, I.
Ophiocamax vitrea, III.
Ophiothamnus vicarius, I.
remotus.
Ophiothrix fragilis, I.
maculata.

Ophiothrix angulata, I.
berberis.
striolata, I.
suensonii, I.
capillaris.
viridialba.
aristulata.
Ophioscolex glacialis, III.
dentatus.
Ophiohelus umbella.
Ophiomyces frutectosus, III.
Ophiobyrsa rudis.
Ophiomyxa flaccida, I., III.
australis, I., III.
vivipara, III.
Hemieuryale pustulata, III.
Sigsbeia murrhina, III.
Astrophyton cœcilia.
Gorgonocephalus pourtalesii.
mucronatus.
eucnemis.
Astroclon propugnatoris.
Astrocnida isidis.
Astroporpa annulata.
affinis.
Astrogomphus vallatus, III.
Astrotoma agassizii.
Astroschema oligactes, III.
tumidum.
tenue.
Ophiocreas lumbricus, III.
Astronyx loveni, III.

Number of Species in Table II., 151.

TABLE III.—Species appearing below 150 and above 500 fathoms.

Ophiopeza peterszi.
Ophiopœpale goësiana, II.
Ophiozona nivea II.
insularia.
tessellata.
antillarum.
depressa.
Ophiothyreus goësii, II.
Ophiopyrgus wyville-thomsoni.
Ophioglypha albida, I., II.
acervata, II.
carnea, II.
sarsii, I., II.
affinis, I., II.
falcifera.
flagellata.
palliata, IV., V.
lepida, IV., V.
ljungmani.
imbecillis.
Ophioglypha lymani, II.
irrorata, IV., V.
jejuna.
elevata.
variabilis, IV., V.
ponderosa.
inermis.
Ophiocten abyssicolum, II.
depressum.
Ophiomusium eburneum.
serratum.
cancellatum.
acuferum, II.
validum, IV., V.
testudo, II.
pulchellum, IV., V.
Ophiomastus tegulitius, IV., V.
secundus.
Ophiopyren brevispinus.
longispinus.

Ophioconis miliaria.
pulverulenta.
Ophiochæta (?) *mixta.*
Ophiopholis aculeata, I., II.
japonica, IV.
Ophiactis mulleri, var. *quinqueradia*, I., II.
asperula, II.
flexuosa, II., IV.
nama, IV.
hirta.
abyssicola.
pectorale.
Amphiura divaricata (?).
complanata (?).
bellis, IV.
studeri, I., II.
grandisquama, I., II.
josephinæ.
iris, IV.
semiermis, IV.
glabra.
sarsii, I., II., IV.
borealis, II.
anomala.
tenuispina, II.
goësii.
duplicata, II., IV., V.
impressa (?).
depressa (?).
glauca.
cuneata.
tumida.
Amphilepis norvegica, II., IV., V.
Ophiocnida caribea (?).
Ophiopsila fulva, I., II.
Ophiocentrus aculeatus.
Ophiopus arcticus, I.
Ophiochiton fastigatus.
Ophiacantha tuberculosa.
sertata.
rosea, II., IV.
vivipara, I., II., IV.
bidentata, I., II., IV., V.
millispina.
anomala.
hirsuta, II.
abnormis, IV.
troscheli, II.
cuspidata.
aspera.
indica.
scutata.
cosmica, IV., V.
pentacrinus, II., IV.
abyssicola, I., II.
levispina.
marsupialis.
Ophiolebes claviger.
humilis, II.
scorteus, IV., V.
vestitus, II.
Ophiomitra plicata, IV.
chelys, IV., V.
dipsacos.
exigua.
normani, IV.
Ophiocamax vitrea, II.
hystrix.
Ophiothrix lütkeni.
pallida.
Ophioscolex glacialis, II.
purpureus.
stimpsoni.
tropicus.
Ophiosciasma attenuatum.
Ophiomyces mirabilis.
frutectosus, II.

Ophiomyxa flaccida, I., II.
australis, I., II.
vivipara, II.
Ophiochondrus convolutus.
Hemieuryale pustulata, II.
Sigsbeia murrhina, II.
Gorgonocephalus malmgrenii.
Astrogomphus vallatus, II.
Astrochele lymani, IV.
Astrotoma murrayi.
Astroschema oligactes, II.
brachiatum.
rubrum.
sulcatum.
intectum.
Ophiocreas lumbricus, II.
carnosus.
caudatus.
œdipus.
Astronyx loveni, II.

Number of Species in Table III., 137.

TABLE IV.—Species appearing below 500 and above 1000 fathoms.

Pectinura heros.
Ophiozona (?) *dubia.*
Ophioceramis (?) *clausa.*
Ophiopleura borealis.
artica (no depth given but probably belongs here).
Ophioglypha meridionalis, V.
palliata, III., V.
lepida, III., V.
irrorata, III., V.
albata.
variabilis, III., V.
lapidaria.
rugosa.
confragosa.
Ophiomusium planum.
lymani, V.
validum, III., V.
scalare.
pulchellum, III., V.
Ophiomastus tegulitius, III., V.
Ophiophyllum petilum.
Ophiopholis japonica, III.
Ophiactis flexuosa, III.
cuspidata.
nama, III.
Ophiactis poa, V.
Amphiura bellis, III.
otteri, V.
argentea.
acacia.
iris, III.
semiermis, III.
lanceolata.
sarsii, I.–III.
lunaris.
duplicata, II., III., V.
concolor, V.
canescens.
Amphilepis norvegica, II., III., V.
Ophiochiton lentus.
Ophiacantha vepratica.
rosea, II., III.
vivipara, I.–III.
bidentata, II., III., V.
stimulea.
echinulata.
abnormis, III.
smittii.
cornuta.
cosmica, III., V.
pentacrinus, II., III.

Ophiolebes scorteus, III., V.
Ophiomitra plicata, III., V.
chelys, III., V.
normani, III.
Ophiothamnus affinis.
Ophiomyces spathifer.
grandis.
Ophiochondrus stelliger.
Astrochele lymani, III.
Astroschema horridum.
arenosum.
salix.
Astroceras pergamena.

Number of Species in Table IV., 65.

TABLE V.—Species appearing below 1000 fathoms.

Ophiozona stellata.
Ophioplinthus medusa.
grisea.
Ophiernus vallincola.
Ophioglypha meridionalis, IV.
palliata, III., IV.
lepida, III., IV.
æqualis.
irrorata, III., IV.
orbiculata.
undulata.
loveni.
fraterna.
bullata.
convexa.
sculptilis.
variabilis, III., IV.
ornata.
lacazei.
lienosa.
radiata.
undata.
minuta.
inornata.
Ophiocten amitinum.
umbraticum.
pallidum.
hastatum.
Ophiomusium armigerum.
Ophiomusium corticosum.
archaster.
lymani, IV.
validum, III., IV.
granosum.
pulchellum, III., IV.
Ophiomastus tegulitius, III., IV.
Ophiotrochus panniculus.
Ophiactis pœa, IV.
canotia.
Amphiura otteri, IV.
duplicata, II.–IV.
concolor, IV.
dalea.
cernua.
verrilli.
patula.
Amphilepis norvegica, II.–IV.
patens.
papyracea.
tenuis.
Ophiocnida scabra.
Ophiocymbium cavernosum.
Ophiochytra epigrus.
Ophiacantha placentigera.
bidentata, I.–IV.
sentosa.
segesta.
nodosa.

Ophiacantha cosmica, III., IV.
Ophiolebes scorteus, III., IV.
Ophiomitra plicata, III., IV.
sarsii.
chelys, III., IV.
carduus.
Ophiambix aculeatus.
Ophiogeron edentulus.
Ophiohelus pellucidus.
Ophiotholia supplicans.
Ophiocreas abyssicola.

Number of Species in Table V., 69.

EPITOME.

Species found in Table I., above 30 fathoms,	278
„ „ II., from 30 to 150 fathoms,	151
„ „ III., from 150 to 500 fathoms,	137
„ „ IV., from 500 to 1000 fathoms,	64
„ „ V., below 1000 fathoms,	69
Species found only in Table I. above 30 fathoms,	226
„ „ II. between 30 and 150 fathoms,	69
„ „ III. between 150 and 500 fathoms,	72
„ „ IV. between 500 and 1000 fathoms,	32
„ „ V. below 1000 fathoms,	50
Species descending from Table I., II.,	52
„ „ I.–III.,	14
„ „ I.–IV.,	2
„ „ I.–V.,	1
„ „ II., III.,	30
„ „ II.–IV.,	5
„ „ II.–V.,	2
„ „ III., IV.,	20
„ „ III.–V.,	13
„ „ IV., V.,	5

Of about 500 species in the two families, the preceding tables show us that more than one-half (278) are found above the depth of 30 fathoms, and of these, that 226 species go no deeper, but cling close to the land, from low-water mark to 180 feet. The remaining fifty-two species descend not further than 150 fathoms, except fourteen, whose depth is less than 500, again excepting two species that go lower than 500 but do not reach 1000 fathoms. Below this last point only one littoral Ophiuran has been found, *Ophiacantha bidentata*. Of the 151 species found between 30 and 150 fathoms, sixty-nine are not found either above or below; two descend from below 30 to below 1000 fathoms; five to below 500; and thirty to below 150 fathoms. A nearly equal number

137 species, are found between 150 and 500 fathoms, whereof seventy-two are confined within those limits, while thirteen descend from below 150 to below 1000 fathoms; and twenty to below 500. Between 500 and 1000 there have been discovered sixty-four species, whereof one-half, or thirty-two, are confined to those limits, while five descend from the starting-point below 500 to below 1000 fathoms. Finally, sixty-nine species in all get below 1000 fathoms, and of these fifty do not pass above that limit. Of course these numbers are temporary. More dredging will bring more species, and will extend the bathymetric range of many, and increase the proportion of the deep-water species to those of the littoral zone, which hitherto has been much more carefully explored. Nevertheless we may say, in general terms, that a very large proportion live exclusively on the littoral zone, and that therein are included species both of cold and of hot water, though the number of the latter is much the larger. Then there is a large fauna of fifty species, which live exclusively below 1000 fathoms and which have to endure a degree of cold near to freezing, an enormous water pressure, and an entire absence of sunlight. Between these extremes there are large groups whose favourite or even necessary habitat is restricted to given depths. Of the genera mentioned in Table I., *Ophioplocus*, *Ophionema*, *Ophionephthys*, *Ophiarachna*, *Ophiarthrum*, *Ophiomastix*, *Ophiopteris*, *Ophiogymna*, *Ophiocnemis*, *Ophiomaza*, *Ophiothela*, *Ophiopsammium*, *Ophioblenna*, *Astrophyton*, *Euryale*, and *Trichaster*, sixteen in all, do not go lower than 30 fathoms, and they, without exception, inhabit warm seas. This proves that certain groups demand a high temperature and cannot accommodate themselves to a lower one. Should any of them, therefore, be found fossil, it would be reasonable to infer that the horizon was a shallow covered by warm water. Nine genera have not yet been found above 1000 fathoms, *Ophioplinthus*, *Ophiernus*, *Ophiotrochus*, *Ophiocymbium*, *Ophiochytra*, *Ophiambix*, *Ophiogeron*, *Ophiohelus*, *Ophiotholia*; their occurrence, therefore, as fossils might denote a geological bottom of great depth and covered by cold water of very heavy pressure. To these might be added those species of *Ophioglypha* with swollen, microscopically tuberculated plates (*e.g.*, *Ophioglypha bullata*), and the species of *Amphiura* having four or five papillæ on each side of the mouth angle (*e.g.*, *Amphiura patula*), One species only, *Ophiacantha bidentata*, penetrates from the littoral zone to the lowest depths. It binds together the bathymetric faunæ as the humble *Amphiura squamata* unites the geographical. Six genera, *Ophiolipus*, *Ophioplax*, *Ophiobyrsa*, *Astroclon*, *Astrocnida*, and *Astroporpa* are found exclusively between 30 and 150 fathoms; five, *Ophiopyrgus*, *Ophiomastus*, *Ophiopyren*, *Ophiocentrus*, and *Ophiosciasma*, between 150 and 500; and four, *Ophiopleura*, *Ophiophyllum*, *Astrochele*, and *Astroceras* between 500 and 1000 fathoms.

TEMPERATURE TABLES.

TABLE I.—Showing Challenger species found between 32° and 38° Fahr. inclusive.

The figure after each species indicates its depth in fathoms. The Roman numeral opposite a species shows that it is found also in one of the other tables thus indicated.

Ophiozona stellata, 1100, II.
Ophioplinthus medusa,[1] 1975.
grisea,[1] 1975.
Ophiernus vallincola, 1000–175.
Ophioglypha sarsii, 3–238, II.
meridionalis, 600–1035.
lepida, 425–1350, II.
æqualis, 1070.
irrorata, 410–1900.
orbiculata, 1875.
undulata, 1850.
albata, 775.
loveni, 1375–2600.
fraterna, 1950.
bullata, 1240–2850.
convexa, 2050–2350.
sculptilis, 1875.
variabilis, 390–1425.
ornata, 2160–2600.
lacazei, 2160–2600.
lienosa, 1950.
radiata, 1050.
undata, 1450.
lapidaria, 565.
minuta, 1375–1800.
deshayesi, 28–150.
inornata, 1850.
confragosa, 600.
Ophiocten amitinum, 120–1260.
umbraticum, 2650.
pallidum, 2600.
hastatum, 1375.
Ophiomusium armigerum, 1650–2200.
corticosum, 1850.
cancellatum, 420–470.
archaster, 1900.
lymani, 565–1825.
granosum, 1875.
Ophiomastus tegulitius, 275–2600, II.
Ophioconis antarctica, 50–150.
Ophiopholis aculeata, littoral to 400, II.
japonica, 420–775.
Amphiura bellis, 210–775, II.
otteri (?), 550–1250, II.
studeri, 20–310.
acacia, 565.
iris, 420–775.
angularis, 150.
squamata, littoral to 120, II., III.
duplicata, 73–1560.
concolor, 800–1425, II.
dalea, 2650.
cernua, 2300.
glauca, 345–420, II.
Amphilepis norvegica, 50–1350.
patens, 2160.
tenuis, 1875.
Ophiocymbium cavernosum, 1950.
Ophiochytra epigrus, 2350.
Ophiacantha placentigera, 1350.
rosea, 150–775.
vivipara, 20–600, II.
bidentata, 5–1350.

[1] No temperature given, but at 1975 fathoms; it must fall within the limits of this table.

Ogphiacantha imago, 25–150.
sentosa, 2225.
stimulea, 950.
segesta, 1075.
cosmica, 350–2225, II.
Ophiolebes scorteus, 310–1600.
Ophiomitra plicata, 500–1050.
sarsii, 1375.
normani, 345–775, II.
Ophiambix aculeatus, 1350.
Ophiogeron edentulus, 1350, II.
Ophiohelus pellucidus, 1350.
Ophiotholia supplicans, 1825.
Ophiomyces spathifer, 565.
Ophiochondrus stelliger, 600.
Gorgonocephalus pourtalesii, 55–140, II.
Ophiocreas abyssicola, 2300.
Astroceras pergamena, 565.
Astronyx loveni, 83–350, II.

TABLE II.—Showing Challenger species found between 39° and 54° Fahr. inclusive, to which are added the shallow water species of the North Atlantic.

The figure opposite each species shows its depths in fathoms; where there is no figure the species belongs in the shallow North Atlantic fauna. A Roman numeral opposite a species shows that it is found also in one of the other tables thus indicated.

Ophiopeza aster, 150.
Pectinura heros, 800.
Ophiozona stellata, 1100, I.
depressa, 500.
Ophioceramis clausa, 630.
Ophioglypha ciliata, 5–100, III.
albida, 5–250, III.
sarsii, 3–238, I.
affinis, 20–192, III.
robusta, 10–100.
flagellata, 340.
lepida, 425–1350.
imbecillis, 345.
lymani, 40–245.
costata, 98–250.
nodosa, 12–50.
stuwitzii, 30.
rugosa, 700.
ponderosa, 340.
Ophiocten sericeum, 15–80.
Ophiomusium lymani, 568–1825.
Ophiomusium scalare, 600.
pulchellum, 150–1675.
Ophiomastus tegulitius, 275–2600.
Ophiophyllum petilum, 600.
Ophiopholis aculeata, littoral to 400, I.
Ophiactis flexuosa, 150–600.
cuspidata, 520–600.
nama, 210–600.
canotia, 1000.
Amphiura bellis, 210–775, I.
otteri, 550–1250, I.
capensis, 98.
argentea, 600.
sundevalli, 15–50.
lanceolata, 700.
glabra, 500.
dilatata, 98.
filiformis.
squamata, littoral to 120, I., III.
torelli

Amphiura concolor, 800–1425, I.
glauca, 345–420, I.
canescens, 600.
Amphilepis papyracea, 2150.
Ophiocnida brachiata, 20, I.
Ophiopus arcticus.
Ophiocoma nigra.
Ophiochiton fastigatus, 345–800.
lentus, 600.
Ophiacantha tuberculosa, 375.
vepratica, 600.
vivipara, 20–600, I.
abnormis, 375–700.
cornuta, 520–600.
cosmica, 320–2225, I.
abyssicola, 200–300.
levispina, 500.
Ophiolebes vestitus, 147–400.

Ophiomitra plicata, 500–1050, I.
normani, 345–775, I.
Ophiothamnus remotus, 150.
Ophiothrix fragilis, 6–52.
pentaphyllum.
aristulata, 38–150.
Ophiogeron edentulus, 1350, I.
Ophiomyxa vivipara.
Gorgonocephalus eucnemis, 36–120.
agassizii.
pourtalesii, 55–140, I.
Astrotoma agassizii, 135.
Astroschema horridum, 630.
salix, 520, 630.
Ophiocreas caudatus, 340.
œdipus, 420–500.
Astronyx loveni, 83, 350, I.

TABLE III.—Showing the principal shallow water species (above the 100 fathom line) of tropical and sub-tropical seas, between 55° and 90° Fahr. inclusive.

Ophiura brevicauda.
guttata.
brevispina.
holmseii.
daniana.
junuarii.
variegata.
lævis.
cinerea.
wahlbergii.
rubicunda.
panamensis.
squamosissima.
teres.
appressa.
tongana.
Ophiopeza fallax.

Ophiopeza yoldii.
Pectinura vestita.
infernalis.
gorgonia.
marmorata.
maculata.
septemspinosa.
rigida.
stellata.
spinosa.
verrucosa.
Ophiolepis cincta.
paucispina.
annulosa.
elegans.
variegata.
Ophioplocus imbricatus.

Ophioplocus esmarkii.
Ophiozona impressa.
pacifica.
nivea.
Ophioceramis albida.
januarii.
Ophioglypha ciliata, II.
sinensis.
albida, II.
acervata.
affinis, II.
Ophioconis forbesii.
brevispina.
Ophiochæta setosa.
Ophiactis savignyi.
resiliens.
loricata.
lymani.
plana.
virens.
simplex.
arenosa.
kröyeri.
nigrescens.
maculosa.
carnea.
Amphiura verticillata.
divaricata.
complanata.
mediterranea.
candida.
grandisquama.
stimpsonii.
constricta.
flexuosa.
latispina.
sarsii.
squamata I., II.
violacea.
Amphiura microdiscus.
puntarenæ.
limbata.
geminata.
subtilis.
gracillima.
riisei.
grisea.
planispina.
barbaræ.
atra.
lütkeni.
chilensis.
örstedii.
repens.
pulchella.
impressa.
lævis.
depressa.
hastata.
andreæ.
Ophionema intricata.
Ophionepthys limicola.
phalerata.
Ophiocnida brachiata, II.
scabriuscula.
hispida.
filogranea.
loveni.
echinata.
pilosa.
putnami.
Hemipholis cordifera.
gracilis.
Ophiophragmus wurdemani.
marginatus.
septus.
Ophiopsila aranea.
annulosa.

Ophiopsila riisei.
fulva.
Ophionereis dubia.
reticulata.
annulata.
schayeri.
porrecta.
Ophioplax ljungmani.
Ophiostigma isacanthum.
tenue.
formosa.
africanum.
Ophiocentrus aculeatus.
Ophiocoma scolopendrina.
erinaceus.
echinata.
riisei.
æthiops.
brevipes.
squamata.
pica.
valenciæ.
pumila.
alexandri.
papillosa.
Ophiarachna incrassata.
affinis.
armata.
Ophiarthum elegans.
pictum.
Ophiomastix annulosa.
caryophyllata.
venosa.
mixta.
asperula.
janualis.
flaccida.
Ophiacantha hirsuta.
troscheli.
Ophiacantha setosa.
longidens.
indica.
stellata.
discoidea.
pentacrinus.
Ophiomitra valida.
Ophiocamax vitrea.
Ophiothamnus vicarius.
Ophiothrix echinata.
alopecurus.
lusitanica.
roseo-cœrulans.
quinquemaculata.
angulata.
örstedii.
spiculata.
magnifica.
rudis.
dumosa.
lineata.
hirsuta.
longipeda.
punctolimbata.
rotata.
planulata.
pusilla.
exigua.
ciliaris.
stelligera.
carinata.
aspidota.
triloba.
propinqua.
nereidena.
galateæ.
cataphracta.
berberis.
martensi.

Ophiothrix virgata.
trilineata.
melanosticta.
striolata.
elegans.
suensonii.
capillaris.
purpurea.
viridialba.
plana.
Ophiogymna elegans.
Ophiocnemis marmorata.
Ophiomaza cacaotica.
obscura.
Ophiothela mirabilis.
danæ.
isidicola.
Ophiopsammium semperi.
Opioblenna antillensis.
Ophiohelus umbella.
Ophiomyces frutectosus.
Ophiomyxa pentagona.
flaccida.
Ophiomyxa australis.
Hemieuryale pustulata.
Sigsbeia murrhina.
Astrophyton costosum.
spinosum.
nudum.
cæcilia.
clavatum.
exiguum.
panamense.
Gorgonocephalus arborescens.
cacaoticus.
verrucosus.
Euryale aspera.
Trichaster palmiferus.
elegans.
Astrocnida isidis.
Astroporpa annulata.
affinis.
Astroschema oligactes.
tenue.
læve.
Ophiocreas lumbricus.

There are not enough observations to render the preceding tables complete or accurate, but their general conclusions are perhaps reliable. Table I. gives the species of cold water; Table II. those of temperate; and Table III. the warm water species. The last, which also are of comparatively shallow water, are by far the most numerous, a proportion which suggests that heat, light, and small pressure tend to produce variety in form and structure; and yet there is not that vast difference between deep cold species and shallow warm ones which might reasonably be looked for on the theory that so called natural forces are alone potent to effect change.

If the present faunæ of the two sides of the Isthmus of Panama, as compared together, have varied so little since the Chalk; or if some deep Atlantic species present no greater changes than they do as compared with the Triassic or the Chalk species, how is it that Ophiuridæ have thus dragged along in narrow limits, while some other animals have almost unbelievably changed? Perhaps we shall be told that it is their nature to drag along, just as Molière's medical student says that opium produces sleep because it possesses a somniferous property.

NOTE ON FOSSIL SPECIES.

In 1869 Lütken published a short but satisfactory critique on the then known fossil Ophiurans.[1] He mentions nearly fifty species, and his general conclusion is that they have no certain standing, either generically or specifically. The latest resumé[2] shows that no real progress in the definition of these fossils has been made during the past twelve years. For this there are two reasons, (1) that many of the type specimens are ill preserved, and especially deficient in the mouth parts; (2) that nobody who knew much of the subject has made a general examination of the originals. Here is an excellent field for a palæontologist. It cannot be doubted that the museums have a great many unstudied species. Indeed I have myself seen some in the European collections. When we consider the variety of living Ophiurans, and their occurrence in every climate and at every depth, it is plain that he would throw much light on palæontology who would bring together and thoroughly study their fossil forms. At present it cannot be said that a single fossil genus is identical with the living. The most probable identity is that of the Oolitic *Ophioderma* (*Ophiura*) *egertoni*,[3] which may well be an *Ophiura*, an *Ophiopeza*, or a *Pectinura*; most probably the last. Another fossil long known is the Triassic *Aspidura loricata*,[4] which certainly has a considerable likeness to *Ophiomastus* (Pl. VIII. figs. 16–18), especially on the under side. Goldfuss has correctly drawn the little primary plates in the centre of the back as in the brachial spaces; and I suspect Polig is wrong in putting them in the interbrachial, where they are never found among the living. I agree, too, with Ludwig that the supposed division in halves of the mouth shields is highly improbable. Another Triassic form, *Aspidura ludeni*,[5] has nearly the whole arm occupied by swollen side arm plates, and may possibly stand near such a species as *Ophiomusium eburneum*. *Ophiolepis damesii* from the Oolite has similar side arm plates;[6] and so has the Oolitic *Ophiolepis leckenbyi*,[7] with the additional peculiarity of a microscopic surface tuberculation like that of *Ophioglypha convexa* and some other deep-sea species (Pl. VI. figs. 13–15). The same large, swollen, tuberculated side arm plates are found in *Ophiocoma granulosa*[8] from the Chalk. On the whole, it may be said that from the Trias upward there is nothing very unfamiliar in the look of the Ophiurans, although to find some of the shapes, we must go into

[1] Addit. ad Hist. Oph., vol. iii. p. 70, 1869.

[2] Zittel, Handbuch der Palæontologie, vol. i. p. 439, 1880.

[3] Broderip, Trans. Geol. Soc., 2nd Ser., pl. xii. fig. 6.

[4] Goldfuss, Petrefacta Germaniæ, pl. xlii. fig. 7; Polig. Zeitschrift f. Wissensch., Zoologie, vol. xxxi. p. 235, pl. xvii. figs. 10–14; Ludwig, Zool., Anzeiger, Jan. 1879, p. 41.

[5] Hagenow, Palæontographica, vol. i. p. 21, pl. i. fig. 1.

[6] Wright, Monog. British Fossil Echinoderm, vol. ii., pl. xxi. figs. 4, 5.

[7] Wright, *loc. cit.*, pl. xix. fig. 3.

[8] Roemer, Versteinerungen des Norddeutschen Kreidegebirges, 1841, pl. vi. fig. 22.

deep water. In the Silurian, however, we have species which are figured with a double row of alternating, angular under arm plates, an arrangement found in no living species.[1] Such are *Ptilonaster princeps* and *Eugaster logani*. It is plain that simple armed Astrophytons begin as low as the coal; for *Onychaster flexilis*, Meek and Worthen, evidently belongs in this group.

Two French authors[2] have endeavoured to discriminate the separate pieces of genera found in the middle Lias marles. In the absence of a general knowledge of the finer anatomy of the hard parts, their attempt is of the most elementary character, but one which nevertheless deserves great praise, for in everything there must be a beginning, and it is always creditable. They found some marles largely composed of this debris, a most important fact, showing that the Triassic Ophiuridæ lived in herds, as they often do now. There is one mouth shield which with much probability they determine as belonging to *Ophioglypha*. The parts referred to *Ophiothrix* may rather, perhaps, belong to some genus near *Ophiacantha*. It is partly with a view to aid similar researches that I have given several plates of the skeletons of Ophiurans.

[1] Twentieth Report Regents of University of New York on State Cabinet, 1867, pl. ix. figs. 8, 9.

[2] Terquem et Berthelin, Étude microscopique, &c., Mem. Soc. Geol. de France, 2ème Série, vol. x. p. 99, 1875 pl. xviii. figs. 22–25.

ABBREVIATIONS.

Abildgaard (Müller), Zool. Dan.
Abildgaard (O. F. Müller), Zoologia Danica, 1789.

Acad. Cæs. Leop. Nova Acta.
Nova Acta Academiæ Cæsareæ Leopoldino-Carolinæ Germanicæ Naturæ Curiosorum.

Addit. ad Hist.
Additamenta ad Historiam Ophiuridarum. C. F. Lutken, part 1, 1858, vol. ii. 1859, vol. iii. 1869.

Agas.—Agassiz, L.

Amer. Journ. Sci.
American Journal of Science and Arts.

Ann. Mag. Nat. Hist.
Annals and Magazine of Natural History.

Anniv. Mem. Bost. Soc. Nat. Hist., 1880.
Anniversary Memoirs of the Boston Society of Natural History, 1880.

Ann. Sci. Nat.
Annales des Sciences Naturelles.

Ay.—Ayres, W. O.

Blainv., Faune Franç. Stell.
Blainville, H. M. D. de, Faune Française. Stellérides.

Blainv., Actinol.
Blainville, H. M. D. de, Manual d'Actinologie, 1834–36.

Bosc, Hist. Nat. Vers.
Bosc, S. A. G., Histoire Naturelle des Vers. Suites à Buffon.

Bronn, Syst. d. urweltl. Pflanz.
Bronn, System der urweltlichen Pflanzenthiere, 1824, 1825.

Bull. Mus. Comp. Zool.
Bulletin of the Museum of Comparative Zoology at Harvard College.

Delle Chiaje, Mem.
Delle Chiaje, S., Memorie sulla Storia e Notomia degli Animali senza Vertebre del Regno di Napoli. Tom. i.–v., 1823–1829.

Dewhurst, Nat. Hist. Ord. Cetacea.
Dewhurst, H. W., Natural History of the Order of Cetacea, 1834.

Dr. Goës, Oph.
Förteckning öfver uti Vestindien af Dr. A. Goës samt under korvetten Josefinas expedition i Atlantiska Oceanen samlade Ophiurider. Öf Kong. Akad., 1871.

Düb. & Kor., Öf. Skandinav. Echin.
Düben, M. W., och Koren, J., Öfversigt af Skandinaviens Echinodermer, 1844. Vetensk. Akad. Handlingar.

Duj. & Hupé, Hist. Nat. Zooph. Echin.
Dujardin, F., et Hupé, Histoire Naturelle des Zoophytes. Echinodermes, 1862.

Echin des Mittelmeeres.
Ludwig, H., Die Echinodermen des Mittelmeeres, Mittheil. der Zool. Station, Neapel, 1879.

Edinb. Phil. Journ.
Edinburgh Philosophical Journal.

Encycloped. Meth.
Encyclopédie Méthodique, Vers cxcii., cxciii., 1827.

Fabr., Fauna Groenl.
Fabricius, O., Fauna Groenlandica, 1780.

Fbs., Brit. Starfishes.
Forbes, E., A History of the British Starfishes, 1841.

Flem., Brit. Anim.
Fleming, John, History of British Animals, 1842.

Gould, Invert. Mass.
Gould, A. A., Report on the Invertebrata of Massachusetts, 1841.

Gray, Rad. Animals Brit. Mus.
Gray, J. Edward, British Animals in the Collection of the British Museum. Part 1. Radiated Animals, 1848.

Grube, Aktin. Echin. u. Wür.
Grube, A. E., Aktinien Echinodermen und Würmer der Adriatischen und Mittelmeeres, 1840.

Heller, C., Zooph. u. Echin. Adriat. Meeres.
Heller, C., Die Zoophyten und Echinodermen des adriatischen Meeres, 1868.

Heller, Lit. Fauna d. Adriat. Meeres.
Heller, C., Untersuchungen über die Litoral-fauna des adriatischen Meeres. Sitz. Akad. Wien., 1863.

Hodge, Trans. Tyneside N. F. Club.
Hodge, G., Transactions of the Tyneside Naturalists' Field Club, vol. v., 1860–1862.

Hutt., Ech. New Zealand.
Hutton, F. W., Echinodermata of New Zealand, 1872.

Ill. Cat. Mus. Comp. Zool.
Illustrated Catalogue of the Museum of Comparative Zoology at Harvard College.

Jahres-Berichte d. Sch. Gesell.
Jahres-Berichte der Schlesischen Gesellschaft.

Johnston, Mag. Nat. Hist.
Johnston, G., Magazine of Natural History.

Journ. Linn. Soc.
Journal of the Linnean Society.

Journ. Phil. Acad.
Journal of the Academy of Natural Sciences of Philadelphia.

Knorr, Deliciæ Nat. Select.
Knorr, G. W., Deliciæ Naturæ Selectæ, 1771.

Kuhl & V. Has., MS.
Kuhl & Van Hasselt, Manuscript quoted by Müller & Troschel.

Leach, Zool. Misc.
Leach, W. E., Zoological Miscellany, 1815.

Le Conte.—Le Conte, J. L.

Linck, De Stell. Mar.
Linck, J. H., De Stellis Marinis, 1733.

Linn., Fauna Suec.
Linnæus, C., Fauna Suecica, 1761.

Linn., Syst. Nat. (Gmelin).
Linnæus, C., Systema Naturæ (Gmelin), 1788–1793.

Linn. Trans.
Transactions of the Linnean Society.

Ljn.—Ljungman, Axel V.

Lmk., Hist. Anim. sans Vert.
Lamarck, J. B., Histoire des Animaux sans Vertèbres, 1st edition, 1816.

Lmk., Syst. Anim. sans Vert.
Lamarck, J. B., Système des Animaux sans Vertèbres, 1801.

Lov.—Lovén, S.

Ltk.—Lütken, Chr. F.

Ludwig.—Ludwig, Hubert.

Lym.—Lyman, Theodore.

Magazin for Naturvid.
Magazin for Naturvidenskaberne.

Mart., Spitz.
Martens, F., Groenlandische oder Spitzbergische Reise-Beschreibung, 1675.

Mém. Soc. Scien. Nat. Neuchatel.
Mémoires de la Société des Sciences Naturelles de Neuchatel.

Michelin, Notes sur l'Ile de la Réunion. Annex A.
Notes sur l'Ile de la Réunion, par L. Maillard. Annex A, par H. Michelin, 1863.

Mittheil. der Zool. Station Neapel.
Mittheilungen der Zoologischen Station zu Neapel.

Monatsb. König. Akad. Berlin.
Monatsberichte der Königlichen preussischen Akademie der Wissenschaften zu Berlin.

Müll. & Tr., Syst. Ast.
Müller, J., & Troschel, F. H., System der Asteriden, 1842.

Norm.—Norman, A. M.

Nye Echin.
G. O. Sars, Nye Echinodermer fra den Norske Kyst. Vid. Selsk. Forh., 1871.

Nyt Mag. Natur.
Nyt Magazin for Naturvidenskaberne, 1857.

O. F. Müll., Zool. Dan. Prodr.
Müller, O. F., Zoologiæ Danicæ Prodromus, 1766.

Öf. Kong. Akad.
Öfversigt af Kongl. Vetenskaps Akademiens Forhandlingar.

Om några nya arter.
A. V. Ljungman, Om några nya arter af Ophiurider. Öf Kong. Akad., 1866.

Om tvänne nya arter.
A. V. Ljungman, Om tvänne nya arter Ophiurider. Öf. Kong. Akad., 1870.

Oph. Nov. Descr.
C. F. Lütken, Ophiuridarum novarum vel minus cognitarum descriptiones nonnullæ. Vid. Selsk. Forh., 1872.

Oph. Viv.
A. V. Ljungman, Ophiuroidea viventia huc usque cognita. Öf. Kong. Akad., 1866.

Örst.—Örsted, A. S.

Pennant, Brit. Zool.
Pennant, T., British Zoology, 1812.

Pet.—Peters, W.

Phil. Trans. Roy. Soc.
Philosophical Transactions of the Royal Society.

Phil.—Philippi, R.A.

Pontoppidan, Natur. Hist. Nor.
Pontoppidan, E., Versuch einer Naturlichen Historie von Norwegen, ii., 1754.

Proc. Bost. Soc. Nat. Hist.
Proceedings of the Boston Society of Natural History.

Proc. Phil. Acad.
Proceedings of the Academy of Natural Sciences of Philadelphia.

Proc. Roy. Soc. Lond.
Proceedings of the Royal Society of London.

Proc. Zool. Soc. Lond.
Proceedings of the Zoological Society of London.

Reitz. Diss.
Retzius, A. J., Dissertatio sistens species cognitas Asteriarum, 1805.

Retz., Asteriæ Gen.
Retzius, A. J., Asteriæ Genus. Kongl. Vetenskaps Akademiens Nya Handlingar, 1783.

Risso, Hist. Nat.
Risso, A., Histoire Naturelle des principales Productions de l'Europe méridionale, 1826.

Rondelet, De Pisc.
Rondelet, G., Libri de Piscibus marinis, 1554.

Sars, Mid. Lit. Fauna.
Sars, M., Bidräg til Kundskaben om Middelhavets Litoral-fauna. Nyt. Mag. Natur., x., 1857.

Sars, Oversigt Norges Echin.
Sars, M., Oversight af Norges Echinodermer, 1861.

Savigny, Descr. de l'Égypte Echin.
Savigny, J. C., Description de l'Égypte. Echinodermes, par V. Audouin, 1809–1817.

Seba, Thesaurus.
Seba, Albertus, Locupletissimi Rerum Naturalium Thesauri accurata Descriptio, 1758.

Sitzungsber. Berlin, Gesell. Nat. Fr.
Sitzungsberichte der Gesellschaft naturforschender Freunde zu Berlin.

Sitz. Akad. Wien.
Sitzungsberichte der Kaiserlichen Akademie der Wissenschaften zu Wien.

Stimp., Invert. Gr. Manan. Smith. Contrib.
Stimpson, Wm., Marine Invertebrata of Grand Manan. Smithsonian Contributions, 1853.

Suth., Journ. Voy. Baffin's Bay.
Sutherland, P. C., Journal of a Voyage to Baffin's Bay. Appendix by E. Forbes, 1852.

Thomp., Ann. Nat. Hist.
Thompson, W., Some Invertebrata new to the Irish Fauna. Annals of Natural History, v., 1840.

Trans. Conn. Acad.
Transactions of the Connecticut Academy of Arts and Sciences.

Tillägg Skan. Oph.
A. V. Ljungman, Tillägg till kännedomen af Skandinaviens Ophiurider. Öf Kong. Akad., 1864.

Troschel, Sitzung. niederrhein. Gesell. in Bonn.
Troschel, F. H., Sitzungsberichte der niederrheinischen Gesellschaft in Bonn, 1879.

Vid. Meddel.
Videnskabelige Meddelelser fra den naturhistoriske Forening i Kjöbenhavn.

Vid. Selsk. Forh.
Oversigt over det Kongelige Danske Videnskabernes Selskabs Forhandlinger.

v. Mart., Oph. Ind. Oc.
Martens, E. von, Die Ophiuriden des indischen Oceans, Wieg. Archiv, xxxvi., 1870.

Vl.—Verrill, A. E.

Wern. Mem.
E. Forbes, Asteriden of the Irish Sea: Memoirs of the Wernerian Society, viii., 1839.

Wieg., Archiv.
Wiegmann, Dr. Aug., Archiv für Naturgeschichte.

Wyv. Thom., Voy. Chall. Atlantic.
Thomson, C. Wyville, Voyage of the Challenger. The Atlantic, 1877.

Zeits. für Wissen Zoologie.
Zeitschrift für Wissenschaftliche Zoologie.

EXPLANATION OF THE PLATES.

PLATE I.

Fig. 1. *Ophiomusium validum*, Ljn., below, $\frac{2}{1}$.
„ 2. „ „ above, $\frac{2}{1}$.
„ 3. „ „ arm joints in profile, $\frac{2}{1}$.
„ 4. „ *scalare*, Lym., below, $\frac{1}{1}^{2}$
„ 5. „ „ above, $\frac{1}{1}^{2}$.
„ 6. „ „ arm joints in profile, $\frac{1}{1}^{2}$.
„ 7. „ *simplex*, Lym., below, $\frac{1}{1}^{0}$.
„ 8. „ „ above, $\frac{1}{1}^{0}$.
„ 9. „ „ arm joints in profile, $\frac{1}{1}^{0}$.
„ 10. „ *granosum*, Lym., below, $\frac{3}{1}$.
„ 11. „ „ above, $\frac{3}{1}$.
„ 12. „ „ arm joints in profile, $\frac{3}{1}$.
„ 13. „ *lunare*, Lym., below, $\frac{1}{1}^{0}$.
„ 14. „ „ above, $\frac{1}{1}^{0}$.
„ 15. „ „ arm joints in profile, $\frac{1}{1}^{0}$.
„ 16. „ *lütkeni*, Lym., below, $\frac{5}{1}$.
„ 17. „ „ above, $\frac{5}{1}$.
„ 18. „ „ arm joints in profile, $\frac{5}{1}$.

PLATE II.

Fig. 1. *Ophiomusium serratum*, Lym., below, $\frac{4}{1}$.
„ 2. „ „ above, $\frac{4}{1}$
„ 3. „ „ arm joints in profile, $\frac{6}{1}$.
„ 4. „ *archaster*, Wyv. Thom., below, $\frac{5}{1}$.
„ 5. „ „ above, $\frac{5}{1}$.
„ 6. „ „ arm joints in profile, $\frac{5}{1}$.
„ 7. „ *armigerum*, Lym., below, $\frac{6}{1}$.
„ 8. „ „ above, $\frac{6}{1}$.
„ 9. „ „ arm joints in profile, $\frac{6}{1}$.

Fig. 10. *Ophiomusium laqueatum*, Lym., below, $\frac{5}{1}$.
„ 11. „ „ above, $\frac{5}{1}$.
„ 12. „ „ arm joints in profile, $\frac{5}{1}$.
„ 13. „ *corticosum*, Lym., below, $\frac{5}{1}$.
„ 14. „ „ above, $\frac{5}{1}$.
„ 15. „ „ arm joints in profile, $\frac{5}{1}$.
„ 16. „ *cancellatum*, Lym., below, $\frac{8}{1}$.
„ 17. „ „ above, $\frac{8}{1}$.
„ 18. „ „ arm joints in profile, $\frac{8}{1}$.

PLATE III.

Fig. 1. *Ophiomusium pulchellum*, Wyv. Thom., below, $\frac{10}{1}$.
„ 2. „ „ above, $\frac{10}{1}$.
„ 3. „ „ arm joints in profile, $\frac{10}{1}$.
„ 4. „ *flabellum*, Lym., below, $\frac{15}{1}$.
„ 5. „ „ above, $\frac{15}{1}$.
„ 6. „ „ arm joints and edge of disk, $\frac{15}{1}$.
„ 7. *Ophioglypha solida*, Lym., below, $\frac{6}{1}$.
„ 8. „ „ above, $\frac{6}{1}$.
„ 9. „ „ arm joints in profile, $\frac{6}{1}$.
„ 10. „ *inornata*, Lym., below, $\frac{8}{1}$.
„ 11. „ „ above, $\frac{8}{1}$.
„ 12. „ „ arm joints in profile, $\frac{8}{1}$.
„ 13. „ *rugosa*, Lym., below, $\frac{8}{1}$.
„ 14. „ „ above, $\frac{8}{1}$.
„ 15. „ „ arm joints in profile, $\frac{8}{1}$.
„ 16. „ *undata*, Lym., below, $\frac{20}{1}$.
„ 17. „ „ above $\frac{20}{1}$.
„ 18. „ „ arm joints in profile, $\frac{20}{1}$.

PLATE IV.

Fig. 1. *Ophioglypha lepida*, Lym., below, $\frac{8}{1}$.
„ 2. „ „ above, $\frac{8}{1}$.
„ 3. „ „ arm joints in profile, $\frac{8}{1}$.
„ 4. „ *palliata*, Lym., below, $\frac{6}{1}$.
„ 5. „ „ above, $\frac{6}{1}$.
„ 6. „ „ arm joints in profile, $\frac{6}{1}$.

Fig. 7. *Ophioglypha kinbergi*, Lym., below, $\frac{8}{1}$ (marked *ferruginea* on the Plate).
„ 8. „ *ljungmani*, Lym., below, $\frac{7}{1}$.
„ 9. „ „ above, $\frac{7}{1}$.
„ 10. „ „ arms joints in profile, $\frac{7}{1}$.
„ 11. „ *imbecillis*, Lym., below, $\frac{1}{1}^{0}$.
„ 12. „ „ above, $\frac{1}{1}^{0}$.
„ 13. „ „ arm joints in profile, $\frac{1}{1}^{0}$.
„ 14. „ *æqualis*, Lym., arm joints in profile, $\frac{7}{1}$.
„ 15. „ „ notch in the disk with two arm joints from above, $\frac{7}{1}$.
„ 16. „ *flagellata*, Lym., below, $\frac{4}{1}$.
„ 17. „ „ above, $\frac{4}{1}$.
„ 18. „ „ arm joints in profile, $\frac{4}{1}$.

PLATE V.

Fig. 1. *Ophioglypha costata*, Lym., below, $\frac{3}{1}$.
„ 2. „ „ above, $\frac{3}{1}$.
„ 3. „ „ arm joints in profile, $\frac{3}{1}$.
„ 4. „ *jejuna*, Lym., below, $\frac{1}{1}^{4}$.
„ 5. „ „ above, $\frac{1}{1}^{4}$.
„ 6. „ „ arm joints in profile, $\frac{1}{1}^{4}$.
„ 7. „ *irrorata*, Lym., below, $\frac{8}{1}$.
„ 8. „ „ above, $\frac{8}{1}$.
„ 9. „ „ arm joints in profile, $\frac{8}{1}$.
„ 10. „ *undulata*, Lym., below, $\frac{5}{1}$.
„ 11. „ „ above, $\frac{5}{1}$.
„ 12. „ „ arm joints in profile, $\frac{5}{1}$.
„ 13. „ *albata* Lym., below, $\frac{7}{1}$.
„ 14. „ „ above, $\frac{7}{1}$.
„ 15. „ „ arm joints in profile, $\frac{7}{1}$.
„ 16. „ *elevata*, Lym., below, $\frac{1}{1}^{2}$.
„ 17. „ „ above, $\frac{1}{1}^{2}$.
„ 18. „ „ arm joints in profile, $\frac{1}{1}^{2}$.

PLATE VI.

Fig. 1. *Ophioglypha ornata*, Lym., below, $\frac{7}{1}$.
„ 2. „ „ above, $\frac{7}{1}$.
„ 3. „ „ arm joints in profile, $\frac{7}{1}$.

Fig. 4. *Ophioglypha lacazei*, Lym., below, $\frac{6}{1}$.
„ 5. „ „ above, $\frac{6}{1}$.
„ 6. „ „ arm joints in profile, $\frac{6}{1}$.
„ 7. „ *lienosa*, Lym., below, $\frac{5}{1}$.
„ 8. „ „ above, $\frac{5}{1}$.
„ 9. „ „ arm joints in profile, $\frac{5}{1}$.
„ 10. „ *variabilis*, Lym., below, $\frac{5}{1}$.
„ 11. „ „ above, $\frac{5}{1}$.
„ 12. „ „ arm joints in profile, $\frac{5}{1}$.
„ 13. „ *convexa*, Lym., below, $\frac{7}{1}$.
„ 14. „ „ above, $\frac{7}{1}$.
„ 15. „ „ arm joints in profile, $\frac{7}{1}$.
„ 16. „ *sculptilis*, Lym., below, $\frac{6}{1}$.
„ 17. „ „ above, $\frac{6}{1}$.
„ 18. „ „ arm joints in profile, $\frac{6}{1}$.

PLATE VII.

Fig. 1. *Ophioglypha radiata*, Lym., below, $\frac{7}{1}$.
„ 2. „ „ above, $\frac{7}{1}$.
„ 3. „ „ arm joints in profile, $\frac{7}{1}$.
„ 4. „ *inermis*, Lym., below, $\frac{5}{1}$.
„ 5. „ „ above, $\frac{5}{1}$.
„ 6. „ „ arm joints in profile, $\frac{5}{1}$.
„ 7. „ *ponderosa*, Lym., below, $\frac{2}{1}$.
„ 8. „ „ above, $\frac{2}{1}$.
„ 9. „ „ arm joints in profile, $\frac{2}{1}$.
„ 10. „ *minuta*, Lym., below, $\frac{1.5}{1}$.
„ 11. „ „ above, $\frac{1.5}{1}$.
„ 12. „ „ arm joints in profile, $\frac{1.5}{1}$.
„ 13. „ *deshayesi*, Lym., below, $\frac{4}{1}$.
„ 14. „ „ above, $\frac{4}{1}$.
„ 15. „ „ arm joints in profile, $\frac{4}{1}$.
„ 16. „ *lapidaria*, Lym., below, $\frac{7}{1}$.
„ 17. „ „ above, $\frac{7}{1}$.
„ 18. „ „ arm joints in profile, $\frac{7}{1}$.

PLATE VIII.

Fig. 1. *Ophioglypha loveni*, Lym., below, $\frac{3}{1}$.
„ 2. „ „ above, $\frac{3}{1}$.
„ 3. „ „ arm joints in profile, $\frac{3}{1}$.
„ 4. „ *ambigua*, Lym., below, $\frac{5}{1}$.
„ 5. „ „ notch of the disk in profile, with basal arm joints, $\frac{5}{1}$.
„ 6. „ *fraterna*, Lym., arm joints in profile, $\frac{3}{1}$.
„ 7. „ *confragosa*, Lym., below, $\frac{5}{1}$.
„ 8. „ „ above, $\frac{5}{1}$.
„ 9. „ „ arm joints in profile, $\frac{5}{1}$.
„ 10. „ *orbiculata*, Lym., below, $\frac{4}{1}$.
„ 11. „ „ above, $\frac{4}{1}$.
„ 12. „ „ arm joints in profile, $\frac{4}{1}$.
„ 13. „ *intorta*, Lym., below, $\frac{8}{1}$.
„ 14 „ „ above, $\frac{8}{1}$.
„ 15. „ „ arm joints in profile, $\frac{8}{1}$.
„ 16. *Ophiomastus tegulitius*, Lym., below, $\frac{1}{1}\frac{6}{0}$.
„ 17. „ „ above, $\frac{1}{1}\frac{6}{0}$.
„ 18. „ „ profile of disk, $\frac{1}{1}\frac{6}{0}$.

PLATE IX.

Fig. 1. *Ophiocten umbraticum*, Lym., below, $\frac{8}{1}$.
„ 2. „ „ above, $\frac{8}{1}$.
„ 3. „ „ arm joints in profile, $\frac{8}{1}$.
„ 4. „ *pallidum*, Lym., below, $\frac{5}{1}$.
„ 5. „ „ above, $\frac{5}{1}$.
„ 6. „ „ arm joints on profile, $\frac{5}{1}$.
„ 7. „ *amitinum*, Lym., below, $\frac{1}{1}\frac{0}{0}$.
„ 8. „ „ above, $\frac{1}{1}\frac{0}{0}$.
„ 9. „ „ arm joints in profile, $\frac{1}{1}\frac{0}{0}$.
„ 10. „ *hastatum*, Lym., arm joints in profile, $\frac{6}{1}$.
„ 11. „ „ a notch of the disk with basal arm joints from above, $\frac{6}{1}$.
„ 12. *Ophiotrochus panniculus*, Lym., below, $\frac{1}{1}\frac{0}{0}$.
„ 13. „ „ above, $\frac{1}{1}\frac{0}{0}$.
„ 14. „ „ arm joints in profile, $\frac{1}{1}\frac{0}{0}$.

Fig. 15. *Ophiopyrgus wyville-thomsoni*, Lym., below, $\frac{1}{1}^{2}$.
„ 16. „ „ disk in profile, $\frac{1}{1}^{2}$.
„ 17. „ „ above, $\frac{1}{1}^{2}$.

PLATE X.

Fig. 1. *Ophiacantha tuberculosa*, Lym., below, $\frac{1}{1}^{0}$.
„ 2. „ „ above, $\frac{1}{1}^{0}$.
„ 3. „ „ arm joints in profile, $\frac{1}{1}^{0}$.
„ 4. *Ophiomitra dipsacos*, Lym., below, $\frac{6}{1}$.
„ 5. „ „ above, $\frac{6}{1}$.
„ 6. „ „ arm joints in profile, $\frac{6}{1}$.
„ 7. „ *plicata*, Lym., below, $\frac{4}{1}$.
„ 8. „ „ above, $\frac{4}{1}$.
„ 9. „ „ arm joints in profile, $\frac{4}{1}$.
„ 10. „ *sarsii*, Lym., below, $\frac{5}{1}$.
„ 11. „ „ above, $\frac{5}{1}$.
„ 12. „ „ arm joints in profile, $\frac{5}{1}$.
„ 13. *Ophiosciasma attenuatum*, Lym., above natural size.

PLATE XI.

Fig. 1. *Ophioceramis* (?) *obstricta*, Lym., below, $\frac{1}{1}^{5}$.
„ 2. „ „ above, $\frac{1}{1}^{5}$.
„ 3. „ „ arm joints in profile, $\frac{1}{1}^{5}$.
„ 4. „ (?) *clausa*, Lym., below, $\frac{1}{1}^{4}$.
„ 5. „ „ above, $\frac{1}{1}^{4}$.
„ 6. „ „ arm joints in profile, $\frac{1}{1}^{4}$.
„ 7. *Ophiozona antillarum*, Lym., below, $\frac{8}{1}$.
„ 8. „ „ above, $\frac{8}{1}$.
„ 9. „ „ arm joints in profile, $\frac{8}{1}$.
„ 10. „ *insularia*, Lym., below, $\frac{1}{1}^{0}$.
„ 11. „ „ above, $\frac{1}{1}^{0}$.
„ 12. „ „ arm joints in profile, $\frac{1}{1}^{0}$.
„ 13. „ *stellata*, Lym., below, $\frac{9}{1}$.
„ 14. „ „ above, $\frac{9}{1}$.
„ 15. „ „ arm joints in profile, $\frac{9}{1}$.
„ 16. „ *depressa*, Lym., below, $\frac{6}{1}$.
„ 17. „ „ above, $\frac{6}{1}$.
„ 18. „ „ arm joints in profile, $\frac{6}{1}$.

PLATE XII.

Fig. 1. *Ophiopyren brevispinus*, Lym., below, $\frac{1}{1}^{8}$.
„ 2. „ „ above, $\frac{1}{1}^{8}$.
„ 3. „ „ arm joints in profile, $\frac{1}{1}^{8}$.
„ 4. „ *longispinus*, Lym., below, $\frac{1}{1}^{2}$.
„ 5. „ „ above, $\frac{1}{1}^{2}$.
„ 6. „ „ arm joints in profile, $\frac{1}{1}^{2}$.
„ 7. *Ophiolebes scorteus*, Lym., below, $\frac{1}{1}^{0}$.
„ 8. „ „ above, $\frac{1}{1}^{0}$.
„ 9. „ „ arm joints in profile, $\frac{1}{1}^{0}$.
„ 10. „ *vestitus*, Lym., below, $\frac{6}{1}$.
„ 11. „ „ above, $\frac{6}{1}$.
„ 12. „ „ arm joints in profile, $\frac{6}{1}$.
„ 13. *Ophiophyllum petilum*, Lym., below, $\frac{1}{1}^{0}$.
„ 14. „ „ above, $\frac{1}{1}^{0}$.
„ 15. „ „ base of arm and edge of disk in profile, $\frac{1}{1}^{0}$.
„ 16. *Ophiogeron edentulus*, Lym., below, $\frac{1}{1}^{2}$.
„ 17. „ „ above, $\frac{1}{1}^{2}$.
„ 18. „ „ arms joints in profile, $\frac{1}{1}^{2}$.

PLATE XIII.

Fig. 1. *Ophiacantha troscheli*, Lym., below, $\frac{8}{1}$.
„ 2. „ „ above, $\frac{8}{1}$.
„ 3. „ „ arm joints in profile,
„ 4. „ *stimulea*, Lym., below, $\frac{8}{1}$.
„ 5. „ „ above, $\frac{8}{1}$.
„ 6. „ „ arm joints in profile, $\frac{8}{1}$.
„ 7. „ *vepratica*, Lym., below, $\frac{1}{1}^{3}$.
„ 8. „ „ above, $\frac{1}{1}^{3}$.
„ 9. „ „ arm joints in profile, $\frac{1}{1}^{3}$.
„ 10. „ *sentosa*, Lym., below, $\frac{5}{1}$.
„ 11. „ „ above, $\frac{5}{1}$.
„ 12. „ „ arm joints in profile, $\frac{5}{1}$.
„ 13. „ *cosmica*, Lym., below, $\frac{4}{1}$.
„ 14. „ „ above, $\frac{4}{1}$.
„ 15. „ „ arm joints in profile, $\frac{4}{1}$.

PLATE XIV.

Fig. 1. *Ophiothamnus remotus*, Lym., below, $\frac{20}{1}$.
„ 2. „ „ above, $\frac{20}{1}$.
„ 3. „ „ arm joints in profile, $\frac{20}{1}$.
„ 4. *Ophiomitra carduus*, Lym., below, $\frac{6}{1}$.
„ 5. „ „ above, $\frac{6}{1}$.
„ 6. „ „ arm joints in profile, $\frac{6}{1}$.
„ 7. *Ophiacantha granulosa*, Lym., below, $\frac{8}{1}$.
„ 8. „ „ above, $\frac{8}{1}$.
„ 9. „ „ arm joints in profile, $\frac{8}{1}$.
„ 10. *Ophiocamax vitrea*, Lym., below, $\frac{4}{1}$.
„ 11. „ „ above, $\frac{4}{1}$.
„ 12. „ „ arm joints in profile, $\frac{4}{1}$.

PLATE XV.

Fig. 1. *Ophiacantha segesta*, Lym., below, $\frac{20}{1}$.
„ 2. „ „ above, $\frac{20}{1}$.
„ 3. „ *cornuta*, Lym., below, $\frac{6}{1}$.
„ 4. „ „ above, $\frac{6}{1}$.
„ 5. „ „ arm joints in profile, $\frac{6}{1}$.
„ 6. „ *serrata*, Lym., below, $\frac{5}{1}$.
„ 7. „ „ above, $\frac{5}{1}$.
„ 8. „ „ arm joints in profile, $\frac{5}{1}$.
„ 9. „ *cuspidata*, Lym., below, $\frac{4}{1}$.
„ 10. „ „ above, $\frac{4}{1}$.

PLATE XVI.

Fig. 1. *Ophiosciasma attenuatum*, Lym., below, $\frac{9}{1}$. (See also Pl. 10, fig. 13.)
„ 2. „ „ above, $\frac{9}{1}$.
„ 3. „ „ arm joints in profile, $\frac{9}{1}$.
„ 4. *Amphiura iris*, Lym., below, $\frac{10}{1}$.
„ 5. „ „ above, $\frac{10}{1}$.
„ 6. „ „ arm joints in profile $\frac{10}{1}$.
„ 7. „ *argentea*, Lym., below, $\frac{12}{1}$.
„ 8. „ „ above, $\frac{12}{1}$.
„ 9. „ „ arm joints in profile, $\frac{12}{1}$.
„ 10. „ „ spines from tip of the arm seen from below, $\frac{12}{1}$.

Fig. 11. *Amphiura constricta*, Lym., below, $\frac{1}{1}^{4}$.
„ 12. „ „ above, $\frac{1}{1}^{4}$.
„ 13. „ „ arm spines, $\frac{1}{1}^{4}$.
„ 14. „ „ spines from tip of the arm, $\frac{1}{1}^{4}$.
„ 15. *acacia*, Lym., below, $\frac{1}{1}^{0}$.
„ 16. „ „ above, $\frac{1}{1}^{0}$.
„ 17. „ „ arm joints in profile, $\frac{1}{1}^{0}$.
„ 18. *Ophiobyrsa rudis*, Lym., below, $\frac{3}{1}$.
„ 19. „ „ above, $\frac{3}{1}$.
„ 20. „ „ arm joints in profile, $\frac{3}{1}$.

PLATE XVII.

Fig. 1. *Amphiura concolor*, Lym. below, $\frac{8}{1}$.
„ 2. „ „ above (the scaling should be more distinct), $\frac{8}{1}$.
„ 3. „ „ arm joints in profile, $\frac{8}{1}$.
„ 4. „ *patula*, Lym. below, $\frac{5}{1}$.
„ 5. „ „ above (the scaling should be more distinct), $\frac{5}{1}$.
„ 6. „ „ arm joints in profile, $\frac{5}{1}$.
„ 7. „ *canescens*, Lym., below (the disk scales should be more distinct), $\frac{1}{1}^{2}$.
„ 8. „ „ above, $\frac{1}{1}^{2}$.
„ 9. „ „ arm joints in profile, $\frac{1}{1}^{2}$.
„ 10. „ *duplicata* (var.), Lym., below, $\frac{1}{1}^{4}$.
„ 11. „ „ above, $\frac{1}{1}^{4}$.
„ 12. „ „ arm joints in profile (the spines are too slender), $\frac{1}{1}^{4}$.
„ 13. „ *cernua*, Lym., below, $\frac{1}{1}^{2}$.
„ 14. „ „ above, $\frac{1}{1}^{2}$.
„ 15. „ „ arm joints in profile, $\frac{1}{1}^{2}$.
„ 16. „ *verrilli*, Lym., below (the disk scales should be more distinct), $\frac{1}{1}^{2}$.
„ 17. „ „ above, $\frac{1}{1}^{2}$.
„ 18. „ „ arm joints in profile (the spines are too slender), $\frac{1}{1}^{2}$.

PLATE XVIII.

Fig. 1. *Amphiura glauca*, Lym., below, $\frac{1}{1}^{2}$.
„ 2. „ „ above, $\frac{1}{1}^{2}$.
„ 3. „ „ arm joints in profile, $\frac{1}{1}^{2}$.

Fig. 4. *Amphiura bellis*, Lym., below, $\frac{7}{1}$.
„ 5. „ „ above, $\frac{7}{1}$.
„ 6. „ „ arm joint in profile, $\frac{7}{1}$.
„ 7. „ *maxima*, Lym., below, $\frac{5}{1}$.
„ 8. „ „ above, $\frac{5}{1}$.
„ 9. „ „ arm joint in profile, $\frac{5}{1}$.
„ 10. „ „ an under arm plate, $\frac{10}{1}$.
„ 11. „ *dalea*, below, $\frac{7}{1}$.
„ 12. „ above, $\frac{7}{1}$.
„ 13. „ arm joints in profile (spines are too slender), $\frac{7}{1}$.
„ 14. „ *capensis*, Ljn., below, $\frac{8}{1}$. (Referred by error to Lyman in the plate.)
„ 15. „ „ above, $\frac{8}{1}$.
„ 16. „ „ arm joints in profile, $\frac{8}{1}$
„ 17. *Ophiostigma africanum*, Ljn., below, $\frac{20}{1}$.
„ 18. „ „ above, $\frac{20}{1}$.
„ 19. „ „ arm joint in profile, $\frac{20}{1}$.

PLATE XIX.

Fig. 1. *Amphilepis patens*, Lym., below, $\frac{6}{1}$.
„ 2. „ „ above, $\frac{6}{1}$.
„ 3. „ „ arm joint in profile, $\frac{6}{1}$.
„ 4 *Ophiocnida scabra*, Lym., below, $\frac{12}{1}$. (Some of the papillose tentacles are protruded.)
„ 5. „ „ above, $\frac{12}{1}$.
„ 6. „ „ arm joint in profile, $\frac{12}{1}$.
„ 7. „ *pilosa*, Lym., below, $\frac{14}{1}$.
„ 8. „ „ above, $\frac{14}{1}$.
„ 9. „ „ arm joint in profile, $\frac{14}{1}$.
„ 10. *Ophiomyces spathifer*, Lym., below, $\frac{15}{1}$.
„ 11. „ „ above, $\frac{15}{1}$. (The disk is folded as often seen in the genus.)
„ 12. „ „ arm joint in profile, $\frac{15}{1}$.
„ 13. „ *grandis*, Lym., below, $\frac{8}{1}$.
„ 14. „ „ above, $\frac{8}{1}$.
„ 15. „ „ arm joint in profile, $\frac{8}{1}$.
„ 16. *Ophiactis canotia*, Lym., below, $\frac{10}{1}$.
„ 17. „ „ above, $\frac{10}{1}$.
„ 18. „ „ arm joint in profile, $\frac{10}{1}$.

PLATE XX.

Fig. 1. *Ophiactis flexuosa*, Lym., below, $\frac{8}{1}$.
„ 2. „ „ above, $\frac{8}{1}$.
„ 3. „ „ arm joint in profile, $\frac{8}{1}$.
„ 4. „ *hirta*, Lym., below, $\frac{1}{1}^2$.
„ 5. „ „ above, $\frac{1}{1}^2$.
„ 6. „ „ arm joint in profile, $\frac{1}{1}^2$.
„ 7. „ *resiliens*, Lym., below, $\frac{8}{1}$.
„ 8. „ „ above, $\frac{8}{1}$.
„ 9. „ „ arm joint in profile, $\frac{8}{1}$.
„ 10. „ *vuspidata*, Lym., below, $\frac{1}{1}^0$.
„ 11. „ „ above, $\frac{1}{1}^0$.
„ 12. „ „ arm joint in profile, $\frac{1}{1}^0$.
„ 13. „ *poa*, Lym., below, $\frac{1}{1}^2$.
„ 14. „ „ above, $\frac{1}{1}^2$.
„ 15. „ „ arm joint in profile, $\frac{1}{1}^2$.
„ 16. „ *nama*, Lym., below, $\frac{1}{1}^0$.
„ 17. „ „ above, $\frac{1}{1}^0$.
„ 18. „ „ arm joint in profile, $\frac{1}{1}^0$.

PLATE XXI.

Fig. 1. *Ophiothrix berberis*, Lym., above, $\frac{6}{1}$.
„ 2. „ „ below, $\frac{6}{1}$.
„ 3. „ „ arm joint in profile, $\frac{6}{1}$.
„ 4. „ „ arm spine, $\frac{6}{1}$.
„ 5. „ *capillaris*, Lym., below, $\frac{3}{1}$.
„ 6. „ „ above, $\frac{3}{1}$.
„ 7. „ „ arm joint in profile, $\frac{3}{1}$.
„ 8. „ „ arm spine, $\frac{3}{1}$.
„ 9. „ *aristulata*, Lym., below, $\frac{6}{1}$.
„ 10. „ „ above, $\frac{6}{1}$.
„ 11. „ „ arm joint in profile, $\frac{6}{1}$.
„ 12. „ „ arm spine, $\frac{6}{1}$.
„ 13. *Ophiochondrus stelliger*, Lym., below, $\frac{1}{1}^0$.
„ 14. „ „ above, $\frac{1}{1}^0$.
„ 15. „ „ arm joint in profile, $\frac{1}{1}^0$.
„ 16. *Ophiopeza aster*, Lym., below, $\frac{5}{1}$.
„ 17. „ „ above, $\frac{5}{1}$.
„ 18. „ „ arm joints in profile, $\frac{5}{1}$.

PLATE XXII.

Fig. 1. *Ophiacantha nodosa*, Lym., below, $\frac{4}{1}$.
„ 2. „ „ above, $\frac{4}{1}$.
„ 3. „ „ an arm spine, $\frac{12}{1}$.
„ 4. „ „ thorny stump from the disk, $\frac{29}{1}$.
„ 5. *Astrotoma murrayi*, Lym., below, $\frac{3}{1}$.
„ 6. „ „ above, $\frac{3}{1}$.
„ 7. „ „ arm joints in profile, $\frac{3}{1}$.
„ 8. *Astroschema tumidum*, Lym., below, $\frac{5}{1}$.
„ 9. „ „ above, $\frac{5}{1}$.
„ 10. „ „ arm joints in profile near base, $\frac{5}{1}$.
„ 11. „ „ arm joints in profile near tip of arm, $\frac{5}{1}$.
„ 12. „ *salix*, Lym., below $\frac{5}{1}$. (The apparent mouth papillæ are too large,
„ 13. „ „ and are only scattered grains; so also in fig. 8).
above $\frac{5}{1}$. (The granulation is too scattered.)
„ 14. „ „ arm joints near base of arm, $\frac{5}{1}$.
„ 15. „ „ arm joints near tip of arm, $\frac{5}{1}$.

PLATE XXIII.

Fig. 1. *Ophioconis antarctica*, Lym., below, $\frac{5}{1}$.
„ 2. „ „ above, $\frac{5}{1}$
„ 3. „ „ arm joints in profile, $\frac{5}{1}$.
„ 4. „ *pulverulenta*, Lym., below, $\frac{6}{1}$.
„ 5. „ „ above, $\frac{6}{1}$.
„ 6. „ „ arm joint in profile, $\frac{6}{1}$.
„ 7. *Pectinura heros*, Lym., below, $\frac{3}{1}$.
„ 8. „ „ above, $\frac{3}{1}$.
„ 9. „ „ arm joints in profile, $\frac{3}{1}$.
„ 10. „ *arenosa*, Lym., below, $\frac{7}{1}$.
„ 11. „ „ above, $\frac{7}{1}$.
„ 12. „ „ arm joint in profile, $\frac{7}{1}$.
„ 13. *Ophiopholis japonica*, Lym., below, $\frac{7}{1}$.
„ 14. „ „ above $\frac{7}{1}$.
„ 15. „ „ arm joint in profile, $\frac{7}{1}$.
„ 16. *Ophiochiton lentus*, Lym., below, $\frac{5}{1}$.
„ 17. „ „ above, $\frac{5}{1}$.
„ 18. „ „ arm joint in profile, $\frac{5}{1}$.

PLATE XXIV.

Fig. 1. *Ophioscolex tropicus*, Lym., below, $\frac{8}{1}$.
„ 2. „ „ above, $\frac{8}{1}$.
„ 3. „ „ arm joints in profile, $\frac{8}{1}$.
„ 4. „ *dentatus*, Lym., below, $\frac{5}{1}$.
„ 5. „ „ above, $\frac{5}{1}$.
„ 6. „ „ arm joints in profile, $\frac{5}{1}$.
„ 7. *Ophioplinthus medusa*, Lym., below, $\frac{4}{1}$.
„ 8. „ „ above, $\frac{4}{1}$.
„ 9. „ „ arm joints in profile, $\frac{4}{1}$.
„ 10. „ *grisea*, Lym., below, $\frac{4}{1}$ (The division of the mouth is a fracture and not constant.)
„ 11. „ „ above $\frac{4}{1}$. (The originals of *O. medusa* and *O. grisea*, were covered with a thick skin, but were partially dried to exhibit the plates.)
„ 12. „ „ arm joints in profile, $\frac{4}{1}$.
„ 13. *Ophiochiton fastigatus*, Lym., below, $\frac{4}{1}$.
„ 14. „ „ above, $\frac{4}{1}$.
„ 15. „ „ arm joints in profile, $\frac{4}{1}$.
„ 16. *Ophiernus vallincola*, Lym., below, $\frac{8}{1}$.
„ 17. „ „ above, $\frac{8}{1}$.
„ 18. „ „ arm joints in profile, $\frac{8}{1}$.

PLATE XXV.

Fig. 1. *Ophiacantha levispina*, Lym., below, $\frac{10}{1}$.
„ 2. „ „ above, $\frac{10}{1}$.
„ 3. „ „ arm joint from above, $\frac{10}{1}$.
„ 4. „ *imago*, Lym., below, $\frac{9}{1}$.
„ 5. „ „ above, $\frac{9}{1}$.
„ 6. „ „ arm joint in profile, $\frac{9}{1}$.
„ 7. „ *longidens*, Lym, below, $\frac{20}{1}$.
„ 8. „ „ above, $\frac{20}{1}$.
„ 9. „ „ arm joint from above, $\frac{20}{1}$.
„ 10. „ *rosea*, Lym., below, $\frac{5}{1}$.
„ 11. „ „ above, $\frac{5}{1}$.
„ 12. „ „ upper, under, and side arm plates with the spines, $\frac{5}{1}$.

PLATE XXVI.

Fig. 1. *Ophiacantha discoidea*, Lym., below, $\frac{9}{1}$.
„ 2. „ „ above, $\frac{9}{1}$.
„ 3. „ „ arm joints in profile, $\frac{9}{1}$
„ 4. „ *abnormis*, Lym., below, $\frac{4}{1}$.
„ 5. „ „ above, $\frac{4}{1}$.
„ 6. „ „ arm joint in profile, $\frac{4}{1}$.
„ 7. „ *valenciennesi*, Lym., below, $\frac{6}{1}$.
„ 8. „ „ above, $\frac{6}{1}$.
„ 9. *Ophiomitra normani*, Lym., below, $\frac{5}{1}$.
„ 10. „ „ above, $\frac{5}{1}$.
„ 11. „ „ arm joint in profile, $\frac{5}{1}$.
„ 12. *Ophiothrix cæspitosa*, Lym., below, $\frac{9}{1}$.
„ 13. „ „ above, $\frac{9}{1}$.
„ 14. „ „ arm joint in profile.

PLATE XXVII.

Fig. 1. *Ophiocymbium cavernosum*, Lym., below, $\frac{8}{1}$. (The mouth angle is not correct: there should be a close line of three mouth papillæ on each side, and a large tentacle socket within the side mouth shield.)
„ 2. „ „ above, $\frac{8}{1}$. (The upper arm plates are too large and long.)
„ 3. „ „ arm joints in profile, $\frac{8}{1}$. (These are drawn upside down.)
„ 4. *Ophiactis pectorale*, Lym., below, $\frac{9}{1}$.
„ 5. „ „ above, $\frac{9}{1}$.
„ 6. „ „ arm joint in profile, $\frac{9}{1}$.
„ 7. *Ophiopeza æqualis*, Lym., below, $\frac{5}{1}$.
„ 8. „ „ above, $\frac{5}{1}$. (The granulation is too spaced.)
„ 9. „ „ arm joints in profile, $\frac{5}{1}$.
„ 10. *Ophiambix aculeatus*, Lym., below, $\frac{16}{1}$. (The side mouth shields should be narrower at their outer ends.)
„ 11. „ „ above, $\frac{16}{1}$.
„ 12. „ „ arm joint in profile, $\frac{16}{1}$.

PLATE XXVIII.

Fig. 1. *Ophiotholia supplicans*, Lym., $\frac{1}{1}$⁰. The entire animal seen in profile, with its arms and disk stretched upward and its mouth angles turned downward, and outward, and armed with their mouth papillæ like those of *Ophiomyces*. On the outer arm joints are the small parasol spines.

„ 2. „ „ $\frac{1}{1}$⁰. Mouth seen from below, showing the spike-like teeth, the foliate, imbricated mouth papillæ, and the two sets of mouth tentacles.

„ 3. „ „ $\frac{3}{1}$⁰. Ninth arm joint from below, showing the side arm plates bearing ordinary spines and within them a bunch of parasol spines. From the large pores issue long smooth tentacles, each protected by a spine-like scale. On drying the specimen there would appear along the central ridge the juncture of the side arm plates.

„ 4. „ „ $\frac{7}{1}$⁵. A single parasol spine mounted on its mamelon.

„ 5. *Ophiohelus pellucidus*, Lym., $\frac{1}{1}$⁰. From below, showing the long mouth tentacles, and the absence of parasol spines near the base of the arm.

„ 6. „ „ $\frac{1}{1}$⁰. From above. The extremely thin disk scales are barely visible by a cross light. The arm bones are in two parallel pieces.

„ 7. , , $\frac{2}{1}$⁰. Ninth, tenth, and eleventh arm joints stripped of skin. On the ninth are three common and one parasol spine. On the other two joints are only the latter sort, arranged in a double row.

„ 8. „ „ $\frac{4}{1}$⁰. A common arm spine treated with potash, to show that it is composed of two parallel spicules, like a disk spine of *Ophiohelus umbella*.

„ 9. „ „ $\frac{5}{1}$⁰. A parasol spine, mounted on its mamelon, and stripped of its skin bag.

Fig. 10. *Ophiohelus umbella*, Lym., $\frac{55}{1}$. A joint close to tip of arm, digested with potash; seen from above. On the upper side is the film-like upper arm plate pierced with numerous holes; to the right and left of it is a side arm plate, also of open structure, and having a spine ridge which consists of two or three crowded, irregular rows of elongated mamelons. On the right these mamelons are shown carrying their parasol spines. Underneath are the curious, curved, translucent bars that are the two halves of the arm bone, united only at their articulating ends.

„ 11. „ „ $\frac{70}{1}$. Scales of disk, one of them bearing a minute spine cleaned with potash to show their open structure, and the mode of growth of the spines.

„ 12. *Ophiochytra epigrus*, Lym., below, $\frac{9}{1}$. (The mouth angle is not correct. There should be a small jaw plate at the apex, the outer mouth papilla should be larger, and the first under arm plate slightly forked.)

„ 13. „ „ above $\frac{9}{1}$.

„ 14. „ „ arm joints in profile $\frac{9}{1}$.

„ 15. *Ophiacantha placentigera*, Lym., below, $\frac{5}{1}$.

„ 16. „ „ above, $\frac{5}{1}$.

„ 17. „ „ arm joints in profile, $\frac{5}{1}$.

PLATE XXIX.

Fig. 1. *Amphiura angularis*, Lym., below, $\frac{8}{1}$.

„ 2. „ „ above, $\frac{8}{1}$.

„ 3. „ „ arm spines, $\frac{8}{1}$.

„ 4. „ *dilatata*, Lym., below, $\frac{14}{1}$.

„ 5. „ „ above, $\frac{14}{1}$.

„ 6. „ „ a side arm plate with its spines in profile, $\frac{14}{1}$.

„ 7. „ *lanceolata*, Lym., below, with one arm complete, $\frac{14}{1}$.

„ 8. „ „ above, with one arm complete, $\frac{14}{1}$.

„ 9. „ „ a side arm plate with its spines in profile, $\frac{14}{1}$.

„ 10. „ *tomentosa*, Lym., below, $\frac{9}{1}$.

„ 11. „ „ above, $\frac{9}{1}$.

„ 12. „ „ a side arm plate with its spines in profile, $\frac{9}{1}$.

PLATE XXX.

Fig. 1. *Astroschema horridum*, Lym., below, with one arm complete, $\frac{4}{1}$.
„ 2. „ „ above, $\frac{4}{1}$.
„ 3. „ „ arm joint near base of arm, $\frac{4}{1}$.
„ 4. „ „ arm joint some distance along the arm, $\frac{8}{1}$.
„ 5. „ *brachiatum*, Lym., below, $\frac{6}{1}$.
„ 6. „ „ above with one arm complete, $\frac{6}{1}$.
„ 7. „ „ arm joint near base of arm in profile, $\frac{6}{1}$.
„ 8. „ „ arm joint some distance along the arm in profile, $\frac{6}{1}$.

PLATE XXXI.

(The alcoholic specimens were allowed partially to dry, and the outlines are, therefore, too sharp.)

Fig. 1. *Ophiocreas carnosus*, Lym., below, $\frac{2}{1}$.
„ 2. „ „ above, $\frac{2}{1}$. (The disk should be more wrinkled and fleshy.)
„ 3. „ „ arm joint near base of arm, $\frac{3}{2}$.
„ 4. „ „ arm joint near tip of arm, $\frac{3}{1}$.
„ 5. „ *œdipus*, Lym., below, $\frac{4}{1}$.
„ 6. „ „ above, $\frac{4}{1}$.
„ 7. „ „ arm joint near base of arm, $\frac{6}{1}$.
„ 8. „ „ arm joint near tip of arm, $\frac{4}{1}$.

PLATE XXXII.

(The alcoholic specimens were allowed partially to dry, and the outlines are, therefore, too sharp.)

Fig. 1. *Ophiocreas abyssicola*, Lym., above, $\frac{4}{1}$. (The radial shields are too strongly marked, and they do not go to the centre.)
„ 2. „ „ below, $\frac{4}{1}$. (The mouth angle is incorrect; there are no mouth papillæ, only irregular grains.)
„ 3. „ „ arm joint near base of arm, $\frac{5}{1}$.
„ 4. „ „ arm joint near tip of arm, $\frac{5}{1}$.
„ 5. „ *caudatus*, Lym., below, $\frac{2}{1}$.
„ 6. „ „ above, $\frac{2}{1}$.
„ 7. „ „ arm joint near base of arm, $\frac{2}{1}$.
„ 8. „ „ arm joint near tip of arm, $\frac{5}{1}$.

PLATE XXXIII.

Fig. 1. *Astroschema rubrum*, Lym., below, $\frac{4}{1}$.
„ 2. „ „ above, $\frac{4}{1}$.
„ 3. „ „ arm joint near base of arm, $\frac{4}{1}$.
„ 4. „ „ arm joint near tip of arm, $\frac{4}{1}$.
„ 5. *Amphiura incana*, Lym., below, $\frac{8}{1}$.
„ 6. „ „ above, $\frac{8}{1}$.
„ 7. „ „ side arm plate in profile with spines, $\frac{8}{1}$.
„ 8. „ *glabra*, Lym., below, $\frac{1}{1}\frac{2}{2}$.
„ 9. „ „ above, $\frac{1}{1}\frac{2}{2}$.
„ 10. „ „ side arm plate in profile with spines, $\frac{1}{1}\frac{2}{2}$.

PLATE XXXIV.

Fig. 1. *Astroceras pergamena*, Lym., below, $\frac{5}{1}$. The mouth angle is incorrect; there are no mouth papillæ, only irregular grains.
„ 2. „ „ above, $\frac{5}{1}$.
„ 3. „ „ arm joint near base of arm, $\frac{5}{1}$.
„ 4. „ „ arm joint midway of arm, $\frac{5}{1}$.
„ 5. „ „ arm joint near tip of arm, $\frac{5}{1}$.
„ 6. *Astroclon propugnatoris*, Lym., entire animal in profile, $\frac{1}{2}$.
„ 7. „ „ below, $\frac{1}{1}$.
„ 8. „ „ above, $\frac{1}{1}$.
„ 9. „ „ arm joint near base of arm, $\frac{1}{1}$.
„ 10. „ „ arm joint beyond first fork, $\frac{1}{1}$.
„ 11. „ „ arm joint at tip of twig, $\frac{1}{1}\frac{0}{0}$.

PLATE XXXV.

(For further remarks on this plate, see generic descriptions of *Astrophyton* and *Euryale*.)

Figs. 1–16. *Euryale aspera*, Lmk.
„ 17–25. *Astrophyton costosum*, Seba.
„ 26. *Gorgonocephalus agassizii*, Lym. (Marked *A. costosum* on the plate.)

Fig. 1. *Euryale aspera*, Lmk., $\frac{4}{1}$. A mouth angle with skin removed to show the large side mouth shields (*b*), jaws (*c*), jaw-plate (*e*), mouth papillæ (*d*), and teeth (*d′*), under arm plate (*h*), side arm plate (*i*).

Fig. 2. $\frac{4}{1}$. A mouth angle from above, with its massive frames (*f*) and very large, swollen, peristomial plate (*v*), jaw (*c*), socket of first mouth tentacle (*r'*).

„ 3. $\frac{8}{1}$. Radial shield (*l*) and genital plate (*o*) in place, with the strong nodular pieces connecting them with the under arm plates (*i*). Beyond are arm bones in profile. The position of the genital opening is indicated by a dotted line; genital scale (*n*), side mouth shield (*b*).

„ 4. $\frac{7}{1}$. Two joints near base of arm, in profile, dried; side arm plates (*i*), bearing tentacle scales (*q*), and continued upward by a double row of small pieces (*j*). On the upper surface are the peculiar dorsal spines (*z*).

„ 5. $\frac{7}{1}$. Skin of one side of an arm joint, flattened and seen from the inside, to show the side arm plate (*i*); the double row of pieces homologous with an upper arm plate (*j*); the dorsal spine (*z*), and the piece, under the skin, which carries it (*j''*).

„ 6. $\frac{7}{1}$. Lower surface of arm at fifth fork from the tip, to show the Ophiuran-like under arm plate (*h*), and the side plates (*i*) bearing tentacle scales (or arm spines).

„ 7. $\frac{10}{1}$. Upper surface of arm, at fifth fork from the tip, with the last dorsal spines (*z*).

„ 8. $\frac{7}{1}$. Terminal twigs of the arm nearly in profile, exhibiting the dorsal spines (*z*), and the elongated, flap-like side arm plates (*i*), which bear hooks or club spines (*q*).

„ 9. $\frac{50}{1}$. Three arm joints near end of arm, in profile but somewhat tipped, so as to show the transition from tentacle hooks to the corresponding club spines. On one side there are only hooks (*q*), supported by elongated side arm plates (*i*). On the other, the club spines already are formed; and these, in turn, gradually take the peg-like shape seen in fig. 6; dorsal spine (*z*).

„ 10. $\frac{100}{1}$. Upper view of a joint from tip of arm (*i*), the much elongated and partly free side arm plate, bearing terminal hooks (*q*). There is a superficial granulation but no upper plate.

„ 11. $\frac{100}{1}$. A similar joint in profile, showing the free side arm plate (*i*), with its two terminal tentacle hooks (*q*).

„ 12. $\frac{100}{1}$. Elongated side arm plate (*i*), and its two hooks (*q*), from a terminal joint of the arm.

„ 13. $\frac{4}{1}$. Outer face of an arm bone, with its characteristic horizontal hour-glass projection (*y*).

„ 14. $\frac{4}{1}$. Inner face of an arm bone with its vertical hour-glass projection (β).

„ 15. $\frac{4}{1}$. Outer face of an arm bone just where the arm forks. The projection (*y*) is much widened.

Fig. 16. $\frac{4}{1}$. Inner face of the next bone beyond, already nearly divided, and with a double hour-glass projection (β).

„ 17. *Astrophyton costosum*, Seba, $\frac{2}{1}$. A mouth angle and parts of the interbrachial spaces and under side of an arm, with the skin removed to show the underlying hard parts. On the outer part of the interbrachial space is a region of naked skin, which is replaced along the arm by large plates, attached to those of the side arm (*i*). There are no under arm plates beyond the first (*h*) nor are there any tentacle pores, the large holes (*i'*) being only spaces between the plates; side mouth shields (*b*), jaw (*c*), continuing the mouth frames; jaw plate (*e*), tooth papillæ (*d'*).

„ 18. $\frac{3}{1}$. Skeleton of one angle of the disk seen from above, the roof being removed and the radial shields (*l*) turned up and outwards. The inner portion of the interbrachial space is plated; genital plate (*o*), genital scale (*n*), mouth-frame (*f*), peristomial plate (*v*), first mouth tentacle (*r'*), jaws (*c*), jaw plate (*e*), spine-like tooth (*d''*).

„ 19. $\frac{40}{1}$. Two joints near the tip of a twig, with the double rows of grains and hooks which stand on the thick triangular side arm plates.

„ 20. $\frac{40}{1}$. A joint, near tip of arm, in profile (*q*), a tentacle hook (tentacle scale) just formed, and standing on a side arm plate (*i*), which also bears a continuation of the double row of grain hooks.

„ 21. $\frac{10}{1}$. (The figure should be turned so that the longer diameter is vertical.) A joint half a dozen forks from the end of the arm. The tentacle hooks have fallen, and the surface is granulated except a part of the side arm plate (*i*) in front of which is a tentacle pore.

„ 22. $\frac{40}{1}$. A joint from a small twig, in profile showing three tentacle hooks (*q*) standing on a side plate (*i*) and changing to blunt spines. The surface granulation is a development of that seen in younger stages.

„ 23. $\frac{4}{1}$. Skeleton of a mouth angle seen in profile from the brachial side; (*x*), articulating surface to the neighbouring similar angle next which are seen the vertical canals of the radial water tube, and the radial nerve mouth frames (*f*), peristomial piece (*v*), sockets for the first and second mouth tentacles (*r''* and *r'*), jaw (*c*), jaw plate (*e*).

„ 24. $\frac{4}{1}$. Outer face of an arm bone with its horizontal hour-glass projection (*y*).

„ 25. $\frac{4}{1}$. Inner face of an arm bone with its vertical hour-glass projection (β).

„ 26. *Gorgonocephalus agassizii*, Lym., $\frac{4}{1}$. An arm bone from below, showing the position of the tentacle sockets (*r*, *r*).

PLATE XXXVI.

(All the figures, except 19, are from very young specimens. For further remarks on this plate, see generic description of *Gorgonocephalus*.)

Fig. 1. $\frac{10}{1}$. *Gorgonocephalus agassizii*, Lym. A very young individual, having a disk little more than 2 mm. in diameter, seen from below. In the inner portion of the right lower interbrachial space there should be a small pimple,—the madreporic shield, or plate. All other plates of the lower surface are concealed by the skin, though those of the back are distinct. There is, as yet, but one full fork to the arm, and the beginning of a second. Curved tentacle scales are continued quite to the base of the arm. The fewness of the forks and their distance from the disk bring to mind *Trichaster*.

„ 2. $\frac{20}{1}$. Two mouth angles and the beginning of an arm of a very young specimen, dried; side mouth shields (*b*).

„ 3. $\frac{20}{1}$. The same specimen seen from above, with the base of an arm. On the back of the disk may be seen the primary plates (*g*) with lines of granules between them; and scales along the edge of the disk and on the upper side of the arm.

„ 4. $\frac{75}{1}$. Tip of arm of a young specimen. The side arm-plates (*i*) are already formed, and the hooks.

„ 5. $\frac{75}{1}$. The same, from above, with two additional joints. The side arm plates (*i*) still occupy the whole surface; but, on the central line, a small scale, homologous with the upper arm plate, is just forming. Later, it adds to itself many similar scales. (See fig. 15.)

„ 6. $\frac{40}{1}$. Lower surface of an arm near tip of a twig, showing the side arm plates, bearing their hooks. This and the other figures of arm joints represent preparations dried to show the details of the plates.

„ 7. $\frac{40}{1}$. Upper surface of a joint from near the tip of a twig, showing the side arm plates, and, between them, thin irregular scales, the homologues of an upper arm plate.

„ 8. $\frac{40}{1}$. A side arm plate in profile, near the tip of a twig, bearing its hooks.

„ 9. $\frac{40}{1}$. A side arm plate, in profile, near the tip of a twig, showing some grains near its edge; also a simple hook, which will later be mounted on a grain.

„ 10. $\frac{15}{1}$. Two joints in profile, somewhat further in than fig. 9. The arm has already risen considerably above the side arm plates (*i*) which bear, on their outer edge, tentacle hooks or scales (*q*) and, above, two grain hooks; while on the body of the arm are three more grain hooks.

„ 11. $\frac{15}{1}$. Arm joint in profile, two forks from the tip, and more developed than in fig. 10. The tentacle hooks (*q*) have grown thick; and the grain hooks have left the side arm plate (*i*), and stand only on the arm grains.

Fig. 12. $\frac{1}{1}^{5}$. Lower side of fig. 11, showing the triple under arm plate (*h*).

„ 13. $\frac{100}{1}$. A grain of the arm, from a terminal twig, bearing a rudimentary hook, which has not yet begun to bend, and exhibits its building by irregular lime spicules.

„ 14. $\frac{120}{1}$. A tentacle hook from near the tip of a twig, in profile, showing the holes of growth, which indicate its formation by two parallel spiculæ. (See also Bull. Mus. Comp. Zool., vol. iii. part 10, pl. iii. fig. 10.)

„ 15. $\frac{40}{1}$. Last fork of the arm, from above. The delicate, tuberculated scaling is a further growth of that shown in fig. 7. One tentacle hook may be seen on each side arm plate.

„ 16. $\frac{40}{1}$. The same fork, from below, showing the large side arm plates meeting on the median line.

„ 17. $\frac{1}{1}^{2}$. Two angles of the disk of a very young specimen, from below. The plates of the interbrachial space (see fig. 2), as well as those of the back, are covered by a granulation, which does not, however, hide the genital plate and scale (*o*, *n*) nor the single madreporic shield (*a*). The large side arm plates (*i*) carry tentacle scales, which have changed from the form of hooks (figs. 10) to that of rough-ended spines the triple under arm plates (*h*, *h*); the first one is, however, single; side mouth shield (*b*), jaw (*c*), jaw plate (*e*), tooth papillæ (*d'*).

„ 18. $\frac{20}{1}$. The skeleton of two mouth angles, from above, and of the intervening arm with the genital plates (*o*). Between their inner ends begin the mouth frames (*f*), outside which are two arm bones; peristomial plates (*v*), divided in halves; a division more or less observable also in the adult, and differing from the single bone in *Euryale aspera* (Pl. XXXV. fig. 2, *v*). The small angle piece sometimes considered the first under arm plate (*v'*), jaw (*c*), jaw plate (*e*), tooth papillæ in a single row (*d'*), mouth tentacles of the first and second pairs, dried and shrivelled (*r'*, *r''*).

„ 19. $\frac{4}{1}$. Mouth angle of an adult, with the base of an arm, and the madreporic shield (*a*), side mouth shield (*b*), jaw (*c*), jaw plate (*e*), tooth papillæ (*d'*), side arm plate divided in two (*i*), tentacle pore (*r*). The rest of the mosaic on the lower side of the arm is the broken under arm plates.

PLATE XXXVII.

Plates XXXVII.–XLIII. represent the internal hard parts, or skeletons, of Ophiurans. Their treatment is nearly uniform. One brachial and portions of the neighbouring interbrachial spaces are presented; and that part of the roof of the disk is shown as if

it had been lifted and turned outwards, so as to expose its under surface. The soft tissues are removed, though, in some cases, the muscles between the arm bones have been left. Besides this there usually are given views of the outer and inner faces of an arm bone, from near the disk; and sometimes a view in profile, or from above, or below.

The same notation is everywhere used as follows :—

a, Mouth shield.
c, Jaw.
d, Mouth papillae; *d'*, tooth papillæ; *d''*, teeth.
e, Jaw plate.
f, Mouth frame, *f'*, *f''*, upper and lower hinges joining a mouth frame to its neighbour.
g, Central primary plate; *g'* brachial primary plate.
h, Under arm plate.
i, Side arm plate.
j, Upper arm plate.
l, Radial shield.
n, Genital scale.
o, Genital plate.
p, Arm spines.
r, tentacle socket; *r'*,*r''*, sockets of first and second mouth tentacles.
s, Marginal scales or disk plates.
t, Lower arm canal; *t'* upper arm canal.
u, Circular nerve ring canal.
v, Peristomial plate; *v'*, angle piece (first under arm plate?).
w, Lower muscle field of arm bone; *w''*, upper muscle field; *w'*, the arm bone as a whole.
δ, Ovarial bursa.
1, Articulating umbo on the inner face of an arm bone.
2, Articulating knobs on the inner face of an arm bone.
3, Hole to receive the articulating peg of the outer face.
4, Shoulder on the outer face to receive the umbo.
5, Holes in the outer face to receive the knobs.
6, Articulating peg.

For a more detailed treatment of the plates, see the descriptions of the genera referred to.

Fig. 1. *Ophiura elaps* (?), Ltk., $\frac{3}{1}$. Expedition of United States steamer "Blake."
,, 2. ,, ,, $\frac{6}{1}$. Outer face of an arm bone.
,, 3. ,, ,, $\frac{6}{1}$. Inner face of an arm bone.
,, 4. *Ophiopæpale goesiana*, Ljn., $\frac{1}{1}\frac{0}{0}$. The peculiar elongated arm bones (*w'*).
,, 5. ,, ,, $\frac{2}{1}\frac{0}{0}$. Outer face of an arm bone. Its unusual height and complex outlines will be noticed.
,, 6. ,, ,, $\frac{2}{1}\frac{0}{0}$. Inner face of an arm bone.
,, 7. *Ophiolepis cincta*, Müll & Tr., $\frac{6}{1}$.
,, 8. ,, ,, $\frac{1}{1}\frac{8}{0}$. Outer face of an arm bone.
,, 9. ,, ,, $\frac{1}{1}\frac{8}{0}$. Inner face of an arm bone.
,, 10. *Ophioplocus imbricatus*, Lym., $\frac{6}{1}$.
,, 11. ,, ,, $\frac{1}{1}\frac{2}{0}$. Outer face of an arm bone.
,, 12. ,, ,, $\frac{1}{1}\frac{2}{0}$. Inner face of an arm bone.
,, 13. *Ophiozona impressa*, Lym., $\frac{8}{1}$. Outer face of an arm bone.
,, 14. ,, ,, $\frac{1}{1}\frac{6}{0}$.
,, 15. ,, ,, $\frac{1}{1}\frac{6}{0}$. Inner face of an arm bone. The umbo is very large and the bone wide.

Fig. 16. *Ophioceramis januarii*, Lym., $\frac{8}{1}$. This and the three preceding genera have massive genital plates, with a small genital scale attached near the inner end.

„ 17. „ „ $\frac{1}{1}^2$. Outer face of an arm bone. The lozenge-shaped depressions on each side of the articulating peg are peculiar.

„ 18. „ „ $\frac{1}{1}^2$. Inner face of an arm bone.

PLATE XXXVIII.

Fig. 1. *Ophioplinthus medusa*, Lym., $\frac{6}{1}$.

„ 2. „ „ $\frac{1}{1}^2$. Outer face of an arm bone.

„ 3. „ „ $\frac{1}{1}^2$. Inner face of an arm bone.

„ 4. „ „ $\frac{1}{1}^2$. Under side of an arm bone (*t'* should be *t*).

„ 5. „ „ $\frac{1}{1}^2$. Upper side of an arm bone (*t* should be *t'*).

„ 6. *Ophiernus vallincola*, Lym., $\frac{6}{1}$.

„ 7. „ „ $\frac{1}{1}^2$. Outer face of an arm bone.

„ 8. „ „ $\frac{1}{1}^2$. Inner surface of an arm bone.

„ 9. „ „ $\frac{1}{1}^2$. Arm bone from below, peculiar in its three-sided outline; the small tentacle sockets (*r*) and the irregular lower canal (*t*).

„ 10. *Ophioglypha lymani*, Ljn., $\frac{5}{1}$.

„ 11. „ „ $\frac{1}{1}^0$. Outer face of an arm bone.

„ 12. „ „ $\frac{1}{1}^0$. Inner face of an arm bone.

„ 13. „ „ $\frac{1}{1}^0$. Profile view of an arm bone.

„ 14. „ *bullata*, Lym., $\frac{1}{1}^1$.

„ 15. „ „ $\frac{1}{1}^8$. Outer face of an arm bone.

„ 16. „ „ $\frac{1}{1}^8$. Inner face of an arm bone.

„ 17. „ „ $\frac{1}{1}^8$. Profile view of an arm bone.

„ 18. *Ophiocten sericeum*, Lym., $\frac{8}{1}$.

„ 19. „ „ $\frac{1}{1}^6$. Outer face of an arm bone.

„ 20. „ „ $\frac{1}{1}^6$. Inner face of an arm bone.

„ 21. „ „ $\frac{1}{1}^6$. Profile view of an arm bone.

„ 22. *Ophioglypha deshayesi*, Lym., $\frac{5}{1}$.

„ 23. „ „ $\frac{1}{1}^0$. Outer face of an arm bone.

„ 24. „ „ $\frac{1}{1}^0$. Inner face of an arm bone.

„ 25. „ „ $\frac{1}{1}^0$. Profile view of an arm bone.

PLATE XXXIX.

Fig. 1. *Ophiolipus agassizii*, Lym., $\frac{5}{1}$. Exp. U. S. Str. "Blake."
,, 2. ,, ,, $\frac{10}{1}$. Outer face of an arm bone.
,, 3. ,, ,, $\frac{10}{1}$. Inner face of an arm bone.
,, 4. *Ophiopyren longispinus*, Lym., $\frac{17}{1}$ (*congispinus*, by error in the plate).
,, 5. ,, ,, $\frac{24}{1}$. Outer face of an arm bone.
,, 6. ,, ,, $\frac{24}{1}$. Inner face of an arm bone.
,, 7. *Ophioconis miliaria*, Lym., $\frac{12}{1}$.
,, 8. ,, ,, $\frac{20}{1}$. Outer face of an arm bone.
,, 9. ,, ,, $\frac{20}{1}$. Inner face of an arm bone.
,, 10. *Ophiomusium serratum*, Lym., $\frac{10}{1}$.
,, 11. ,, *validum*, Ljn., $\frac{10}{1}$. Outer face of an arm bone. By error *serratum* in plate.
,, 12. ,, ,, $\frac{10}{1}$. Inner face of an arm bone.
,, 13. ,, ,, $\frac{10}{1}$. Profile view of an arm bone.
,, 14. *Ophiomastus secundus*, Lym., $\frac{38}{1}$.
,, 15. *Ophiochæta mixta*, Lym., $\frac{10}{1}$.
,, 16. ,, ,, $\frac{12}{1}$. Outer face of an arm bone.
,, 17. ,, ,, $\frac{12}{1}$. Inner face of an arm bone.

PLATE XL.

Fig. 1. *Ophiopsila riisei*, Ltk., $\frac{12}{1}$.
,, 2. ,, ,, $\frac{20}{1}$. Outer face of an arm bone.
,, 3. ,, ,, $\frac{20}{1}$. Inner face of an arm bone.
,, 4. *Ophiophragmus wurdemani*, Lym., $\frac{12}{1}$.
,, 5. ,, ,, $\frac{24}{1}$. Outer face of an arm bone.
,, 6. ,, ,, $\frac{24}{1}$. Inner face of an arm bone.
,, 7. ,, ,, $\frac{12}{1}$. A wing of a mouth frame showing the peculiar ridges on the interbrachial side for the attachment of the outer inter-mouth frame muscles.
,, 8. *Hemipholis cordifera*, Lym., $\frac{15}{1}$.
,, 9. ,, ,, $\frac{20}{1}$. Outer face of an arm bone.
,, 10. ,, ,, $\frac{20}{1}$. Inner face of an arm bone.
,, 11. ,, ,, $\frac{20}{1}$. Disk of a very small specimen from above to illustrate the first appearance of radial shields (*l*) just outside the brachial primary plates (*g'*).

Fig. 12. *Hemipholis cordifera*, Lym., $\frac{2}{1}$. Young with a disk only 5 mm. in diameter, from above, showing the primary plates (*g*,*g'*). No radial shields have yet appeared.

„ 13. *Ophionereis reticulata*, Ltk., $\frac{1}{1}$.

„ 14. „ „ $\frac{1}{1}$. Outer face of an arm bone.

„ 15. „ „ $\frac{1}{1}$. Inner face of an arm bone. Observe the hollow process above the umbo (1).

„ 16. *Amphiura bellis*, Lym., $\frac{1}{1}$.

„ 17. „ „ $\frac{2}{1}$. Outer face of an arm bone.

„ 18. „ „ $\frac{2}{1}$. Inner face of an arm bone.

„ 19. *Amphilepis norvegica*, Ljn., $\frac{1}{1}$.

PLATE XLI.

Fig. 1. *Ophiopeza fallax*, Pet., $\frac{1}{1}$. The interbrachial scaling is omitted.

„ 2. „ „ $\frac{1}{1}$. Outer face of an arm bone.

„ 3. „ „ $\frac{1}{1}$. Inner face of an arm bone.

„ 4. *Ophiomitra valida*, Lym., $\frac{1}{1}$. Bones of a mouth angle from above, with the first arm bone (*w'*); also the genital plate (*o*) and scale (*n*) in position: and a radial shield (*l*) turned somewhat from the arm.

„ 5. „ „ $\frac{1}{1}$. Outer face of an arm bone.

„ 6. „ „ $\frac{1}{1}$. Inner face of an arm bone.

„ 7. *Ophioplax ljungmani*, Lym., $\frac{1}{1}$.

„ 8. *Ophiolebes scorteus*, Lym., $\frac{1}{1}$.

„ 9. *Ophiocamax hystrix*, Lym., $\frac{8}{1}$.

„ 10. „ „ $\frac{1}{1}$. Outer face of an arm bone.

„ 11. „ „ $\frac{1}{1}$. Inner face of an arm bone.

„ 12. *Ophiacantha cuspidata*, Lym., $\frac{9}{1}$.

„ 13. „ „ $\frac{9}{1}$. Outer face of an arm bone.

„ 14. „ „ $\frac{9}{1}$. Inner face of an arm bone.

PLATE XLII.

Fig. 1. *Ophiothamnus vicarius*, Lym., $\frac{7}{1}$. The peculiar genital plate (*o*) placed on top of the arm. The walls of the ovarial bursæ (δ,δ), composed of lime scales.

Fig. 2. *Ophioscolex glacialis*, Müll. & Tr., $\frac{1}{1}$°. Two arm bones (*w'*) and a bit of the skin of the disk, close to its margin, to show the very small genital plate (*o*), genital scale (*n*), and radial shield (*l*).

„ 3. „ „ $\frac{1}{1}$°. A mouth angle, with the bases of two arms, from above showing the very large peristomial plate, in three pieces (*v,v*) and the simple, rounded mouth frames (*f*).

„ 4. „ „ $\frac{1}{1}$°. A mouth angle with the bases of two arms, from below, the skin being removed to show the underlying plates, of which the first under arm plate (*h*) is large and bears two papillæ.

„ 5. *Ophiothrix quinquemaculata*, Müll. & Tr., $\frac{6}{1}$.

„ 6. „ „ $\frac{1}{1}$°. Outer face of an arm bone.

„ 7. „ „ $\frac{1}{1}$°. Inner face of an arm bone. See forward process above umbo (1).

„ 8. „ „ $\frac{7}{1}$. (The figure should be placed vertically.) A mouth angle in profile, exhibiting the large mouth tentacles (*r,r*), the attachment of a fold of the stomach (*St*) to the upper point of the jaw; and the jaw plate bearing tooth papillæ (*d'*), and shorter teeth (*d''*).

„ 9. *Ophiocoma æthiops*, Ltk., $\frac{3}{1}$.

„ 10. „ „ $\frac{3}{1}$. Outer face of an arm bone.

„ 11. „ „ $\frac{3}{1}$. Inner face of an arm bone.

„ 12. „ *echinata*, Agas., $\frac{3}{1}$. Base of an arm, in profile, with the bases of spines (*p,p*), the radial shield (*l*), genital plate (*o*), and the base of its scale (*n*).

„ 13. „ „ $\frac{3}{1}$. Chewing apparatus seen in profile; hinges (*f',f''*) attaching this piece to its fellow on the brachial side; within these are seen the sockets of the two mouth tentacles.

Fig. 14. *Ophiocnemis marmorata*, Müll. & Tr., $\frac{1}{1}^{0}$. Skeleton of the base of an arm, with portions of two mouth angles seen from above. The great radial shield (*l*) is pushed on one side to show the underlying parts.

„ 15. „ „ $\frac{1}{1}^{0}$. An angle of the mouth, with parts of two arm joints seen from below.

„ 16. *Ophiostigma isacanthum*, Lym., $\frac{2}{1}^{7}$. The genital plates (*o*) lie on top of the arm as in *Ophiothamnus*.

PLATE XLIII.

Fig. 1. *Ophiomyxa flaccida*, Ltk., $\frac{1}{1}^{0}$. A side arm plate (*i*), having thorny arm spines (*p*) and continued by broken pieces homologous with an upper arm plate (*j*).

„ 2. „ „ $\frac{1}{1}^{0}$. An under arm plate, seen from above; one side of tentacle socket (*r*).

„ 3. „ „ $\frac{1}{1}^{0}$. Two side arm plates (*i,i*), and an under arm plate (*h*), seen from above and inside. The dark spot is the hole for the tentacle.

„ 4. *Sigsbeia murrhina*, Lym., $\frac{8}{1}$.

„ 5. „ „ $\frac{8}{1}$. Outer face of an arm bone. The structure of the joint resembles that of the Astrophytons.

„ 6. „ „ $\frac{8}{1}$. Inner face of an arm bone.

„ 7. *Hemieuryale pustulata*, V. Mart., $\frac{1}{1}^{2}$.

„ 8. „ „ $\frac{1}{1}^{8}$. Outer faces of an arm bone.

„ 9. „ „ $\frac{1}{1}^{8}$. Inner face of an arm bone.

„ 10. „ „ $\frac{1}{1}^{8}$. Side view of an arm bone. Its length and massiveness are characteristic.

„ 11. *Ophiochondrus convolutus*, Lym., $\frac{1}{1}^{3}$.

„ 12. „ „ $\frac{2}{1}^{0}$. Outer face of an arm bone.

„ 13. „ „ $\frac{2}{1}^{0}$. Inner face of an arm bone.

„ 14. „ „ $\frac{2}{1}^{0}$. Under side of an arm bone.

„ 15. „ „ $\frac{2}{1}^{0}$. Upper side of an arm bone. Both figures show the exceptional length and massiveness.

Fig. 16. *Ophiobyrsa rudis*, Lym., $\frac{3}{1}$. The plastron-like genital plate (*o*) coming high on the arm, having a horn-like scale soldered to it (*n*) is peculiar, as is the large, closely-attached peristomial plate (*v*).

„ 17. „ „ $\frac{10}{1}$. Outer face of an arm bone.

„ 18. „ „ $\frac{10}{1}$. Inner face of an arm bone.

PLATE XLIV.

Fig. 1. *Astroschema oligactes*, Ltk., $\frac{10}{1}$. A mouth angle, with its two neighbouring mouth frames (*f*), and one arm bone from above. The massive radial shield (*l*) is turned on one side, exposing the thick genital plate (*o*) with its elementary scale (*n*). The angle piece (*e'*) is very conspicuous. In simplicity and massiveness, the skeleton has some likeness to that of *Hemieuryale*.

„ 2. „ „ $\frac{10}{1}$. Outer face of an arm bone, with a joint of the true *Astrophyton* type. 4 is the hollow corresponding to the articulating shoulder among Ophiurans.

„ 3. „ „ $\frac{10}{1}$. Inner face of an arm bone. 1 is the modified umbo of the Ophiurans.

„ 4. „ „ $\frac{15}{1}$. Arm plates of one joint, viewed diagonally; under arm plate (*h*), side arm plate (*i*), tentacle holes (*r*), broken pieces corresponding to upper arm plates (*j*). The entire arrangement is like that found in *Ophiomyxa*.

„ 5. „ „ $\frac{10}{1}$. A joint, about three-fourths out on the arm, in profile. The granulated skin is slit to show the side arm plate (*i*), carrying a large tentacle scale (spine), and the pieces above. From behind it protrudes the tentacle (*r*). At this point there is no under arm plate, or, at the most, a granule.

Fig. 6. *Ophiomyces frutectosus*, Lym., $\frac{1}{1}^{0}$. Disk and base of an arm seen diagonally from above, showing the large genital openings, with their wide, thin plates (*o*) and scales (*n*). The disk scaling is uniform showing no radial shields; arm spines (*p*).

„ 7. „ „ $\frac{1}{1}^{0}$. Skeleton of the base of an arm, with a mouth angle. A piece of the disk roof is turned up to show its under side, which exhibits no trace of radial shields. This lack is almost unique among Ophiurans. The very wide, thin genital plates (*o*) are striated lengthwise, which shows that they are built up like arm spines, and are not composed of soldered plates.

„ 8. „ „ $\frac{1}{1}^{0}$. Outer face of an arm bone which is peculiar in its simplicity, and in lacking the articulating peg.

„ 9. „ „ $\frac{1}{1}^{0}$. Inner face of an arm bone, with its peculiar umbo (1).

„ 10. *Astrogomphus callatus*, Lym., $\frac{4}{1}$. A genital plate (*o*) and radial shield (*l*) in profile showing that the latter is composed partly of soldered scales, as in *Gorgonocephalus*.

„ 11. „ „ $\frac{4}{1}$. A portion of skin from back of disk, seen from back of disk, seen from the inside, with a pair of radial shields (*l*), and the mosaic of the skin, the central part of which is curled up showing some of the spikes.

„ 12. „ „ $\frac{4}{1}$. Skeleton of a mouth angle from above. Next the peristomial plate (*v*) is the angle piece. The mouth frames (*f*) are like those of *Astroschema*, and approach also those of *Ophioscolex*.

„ 13. *Hemipholis cordifera*, Lym., $\frac{1}{1}^{5}$. (Figs. 13 to 16 are from drawings by the late Professor H. J. Clark, made in Charleston, S. C., in 1852, when an assistant of Professor Agassiz.) Mouth and one angle of the disk of a living specimen: mouth shield (*a*), side mouth shield (*b*), jaw (*c*), jaw

plate (*e*), teeth (*d''*), under arm plate (*h*), first under arm plate (*h'*); lip, or marginal membrane of the mouth (*m*), tentacle scale (*q*), scale of the second mouth tentacle (*q'*) (the dotted line ends on a retracted tentacle); the papillose tentacle (*r*), second mouth tentacle(*r''*).

Fig. 14. *Hemipholis cordifera*, Lym., about $\frac{120}{1}$. Longitudinal section of a tentacle, showing it to be hollow but imperforate. Professor Clark notes three component membranes, or layers; and the peculiar (muscular?) spiral semi-partitions, whose function is doubtless to retract the organ.

„ 15. „ „ about $\frac{120}{1}$. Part of a tentacle, showing the rounded end and the papillæ.

„ 16. „ „ An egg taken from the animal in January, Professor Clark notes that it has a bluish-grey appearance, and is densely filled with minute yolk-granules.

PLATE XLV.

(For further observations see the descriptions of the genera and species referred to.)

Fig. 1. *Ophioglypha hexactis*, E. A. Smith, $\frac{6}{1}$. Vertical cross-cut of a large viviparous ♀ parallel to and a little beside the axis of one arm, and through the edge of the opposite interbrachial space. Above are seen two young (*Y,Y'*) with fragments of arms cut off belonging to them, or to others. One is a tip (near *Y*) showing the terminal tentacle tube. Threads (*Sm*) from the roof, supporting the digestive empty cavity; fold of a bursa (*ð*); section of the aboral, or marginal canal (*lb*), to the left of which is the abductor muscle through whose bundles is thrust the tip of the arm of a young, here seen in section; a portion of the genital scale cut lengthwise (*n*); genital plate (*o*); lower part of the ovarial bursa (*ð*); a fold of the digestive cavity pressing into the bursa (*St*); spines attached to slice of a side arm plate (*p, p*); section of part of the inter-mouth frame muscle (*f,m*); water ring (*f, b*); inner perihæmal canal (*f,c*); canal of the ring nerve (*u*), a section of which is below, while above is seen the smaller

aboral blood ring; the stomach sphincter (*du*) pierced by a ring canal; inter-jaw muscle (*cm*); second mouth tentacle (*r''*), above which is the first, marked (*r'*) on the opposite side; irregular teeth or tooth papillæ (*d'*); jaw plate (*e*); tentacle scales of the mouth (*q*); lower inter-arm bone muscle (*w*); lower arm canal (*t*); upper arm canal (*t'*); water tubes to the tentacles (*rt*); upper arm plate (*j*).

Fig. 2. *Gorgonocephalus pourtalesii*, Lym., $\frac{2}{1}$. Vertical cross-cut through part of the disk of a ♀: digestive cavity (*St*) with its radiating arm lobes (*St'*), and upper lobes (*St''*); the ovaries (*∂*), with which the disk is festooned, and of which many are attached to the radiating lobes of the digestive cavity; stomach sphincter (*du*); (*∂f*), partial ring canal made by a ligament attaching the floor of the digestive cavity to the upper part of the mouth frames (*f*); first and second mouth tentacles (*r'*,*r''*); papillæ of mouth (*d*).

„ 3. „ „ $\frac{1}{1}$. Horizontal cross-cut through a portion of the disk, just above the arms, passing through the radial shields (*l*), the ovarial lobes (*∂*), and radiating lobes of the digestive cavity (*St''*), and exposing the digestive cavity (*St*) and its sphincter (*du*); genital opening (*no*).

„ 4. „ „ $\frac{2}{1}$. A section, inclined from the vertical, to show the interior of one brachial and two interbrachial spaces, above the mouth, looking from the centre outward. The digestive cavity is cut through on its floor (*St*) just at the sphincter; and again above where it passes into the thin lobes (*St'*, *St''*), which below are strongly attached to the outer angle of the mouth frames. (*Am*) upper surface of an arm with a lobe of the digestive cavity (*St'*) attached to it.

Fig. 5. *Gorgonocephalus pourtalesii*, Lym., $\frac{1}{1}^{0}$. Horizontal cross-cut of the end of an ovarial lobe, showing its wall, and the egg clusters, each of which is surrounded by a membrane.

„ 6. *Euryale aspera*, Lmk., $\frac{3}{1}$. Vertical cross-cut of the disk, passing near one arm, on the right; and about through the centre of an interbrachial space, on the left. Above is the digestive cavity with its radiating membranous partitions, and a much expanded genital opening (*no*) on each side. Below are the mouth angles, cut through, and teeth (*d''*); partial ring canal (*δ,f*); corresponding to the inner perihæmal, and which connects the inner ends of the ovarial pouches; second mouth tentacle, above which is the first (*r''*); radial shields cut through (*l,l*).

„ 7. „ „ $\frac{7}{1}^{5}$. Vertical section of skin from roof of disk. It seems uniform and somewhat fibrous, except the lowest granular layer, which may, and should be the egg or spermatozoon bearing tissue. The upper dark band is the pigment layer.

„ 8. „ „ $\frac{7}{1}^{0}$. Some cells from the lowest granular layer of fig. 7, after long immersion in alcohol.

„ 9. „ „ $\frac{3}{1}^{0}$. Bit of lime network from the wall of an ovarial pouch.

PLATE XLVI.

(For further observations, see the description of the genera and species referred to.)

Fig. 1. *Ophiocreas œdipus*, Lym., ♂, $\frac{4}{1}$. Base of an arm and outer margin of disk, with the skin slit on one side and folded back, exposing the right, double-lobed spermary (*δ,δ*) connected within with a spermatic bursa or pouch, which empties outwardly by a genital opening (*no*). Above is the digestive cavity (*St*).

„ 2. *Astrocnida isidis*, Lym., ♀, $\frac{3}{1}$. [Exp. U. S. str. "Blake."] Vertical cross-cut passing through a part of the disk, and somewhat on one side of the median line of an arm, showing the less complex *Astrophyton* character of the internal arrangement; folds of the digestive cavity (*St'*) which has no points of attachment on its under side; the ovaries (*δ*) or egg-clusters lying in the

main, or body cavity; mouth sphincter (*du*) just outside which is the inner perihæmal canal; spinous papillæ of the mouth (*d*); second mouth tentacle (*r''*), above which is the first; mouth frame cut through (*f*); lower arm canal (*t*); an arm bone (*w'*).

Fig. 3. *Ophiura elaps* (?), Ltk., ♂, $\frac{6}{1}$. [Exp. U. S. str. "Blake."] Vertical cross-cut beside an arm showing the whole of a spermatic bursa (*Bu*), with the fold of its membrane (*Bu'*) which runs upward over the arm; genital lobes (*δ*) hanging in the bursa; the same cut through (*δ'*); inner perihæmal canal (*fc*); position of the outer and inner genital openings (*no, no,* with arrows); parts of side arm plates cut through (*i*); adductor muscle (*rm*) between the genital plate (*o*) and the radial shield (*l*); outer blood ring (*lb*); folds of the digestive cavity (*St*).

„ 4. *Ophiocamax,* sp. nov., ♀, $\frac{14}{1}$. [Exp. U. S. str. "Blake."] Vertical cross-cut of the upper portion of an ovarial bursa (*Bu*) whose wall is plated with lime scales. Above is an embryo (*δ'*), cut through and lying in a pocket (ovarial tube ?) whose wall also has minute lime scales. The bursa clings closely to the wall of the digestive cavity (*St*); section of head of genital plate (*O.*)

„ 5. *Amphiura incana,* Lym., ♂, $\frac{10}{1}$. Vertical cross-cut through a portion of the disk, cutting off one arm, and passing beside another; spermatic bursa (*δ*); convoluted genital lobes (*δ,'δ',δ'*); arm (*am*); Polian vesicle (*po*); an arm bone from the outer side (*w'*); the wrinkled digestive cavity (*St*), with its (epithelial ?) wall.

„ 6. *Ophiopholis aculeata,* Gray, $\frac{5}{1}$. Disk seen diagonally from below, with two arms and one interbrachial space cut away to show the typical Ophiuran digestive cavity, a bag (*St*) attached to the disk-roof by slender threads (*Sm*), many of which are made fast to the radial shields (*l*).

„ 7. *Ophiacantha vivipara,* Ljn., $\frac{5}{1}$. View from within of a vertical cross-cut through two arms (*Am*) close to the edge of the disk, showing the marginal portions of the digestive cavity (*St, St*) almost filled by a thick, wrinkled (epithelial ?) layer. Of the bursæ, two (*δδ*) appear as simple folds or cracks, while the third (*δ'*) has little lobes, doubtless ovarial tubes, connected with it.

„ 8. „ „ ♀, $\frac{8}{1}$. Vertical cross-cut at a right angle to the arm, a little inside the edge of the disk seen from within, showing a section of one arm with its brachial space and a portion of an interbrachial

space on each side. Below is the arm bone, with its under (*h*) and side arm plates (*i*) bearing the spines. On either side passes up the genital opening (*no*) into the bursa with its folded wall which closely follows the pleated digestive cavity (*St*, *St*), with its thick (hepatic, or epthelial ?) layer. One little lobe (*St'*) is pushed into the bursa and cut by the section. The wall of the bursa is a thin continuation of the disk wall ; hence its tendency to calcify. In this species it has fine scales of lime in its substance. In the bursal folds lies a young (Y) ; and two embryos (Y') are seen in side pouches. To the right of the upper arm of the young may be seen a section of a tip of another arm, bent round in a fold of the bursa ; genital plate (*o*) ; tentacle (*r*) ; radial shields cut through (*l*,*l*).

Fig. 9. *Ophiacantha vivipara*, Ljn., ♀, $\frac{3}{1}\frac{5}{0}$. Liver-like cells from the very thick wall of the digestive cavity. This layer seems to be the one spoken of by Ludwig as epithelial.

PLATE XLVII.

Fig. 1. *Astrophyton exiguum*, Agas., $\frac{3}{1}$. Disk from above, with two arms.

„ 2. *Ophioglypha hexactis*, E. A. Smith, ♀, $\frac{4}{1}$. Disk with its roof removed and seen from above. Above the digestive cavity (*St*, *St*), which is ruptured in the middle, lie the genital bursæ (*δδ*), near which may be seen four young ones in several stages of growth. Each is contained in a translucent membranous sac, which is ruptured over the largest.

„ 3. *Ophiocoma scolopendrina*, Agas., ♂, $\frac{3}{1}$. Vertical section of the disk passing through one arm (*Am*) and the opposite interbrachial space : digestive cavity (*St*), whose upper wall adheres to the roof of the disk ; jaw (*c*) ; section of mouth frame (*f*) ; genital plate (*o*) ; genital bursa (*δ*) ; convoluted spermaries (*δ'*,*δ'*).

„ 4. *Ophiothrix longipeda*, Müll. & Tr., ♀, $\frac{3}{1}$. Vertical section of the disk passing through one arm (*Am*) and the edge of the opposite interbrachial space, including a slice of an arm (*Am*). The spaces over and beside the arms

are crammed with minute eggs (δ',δ''), which press on the genital bursæ (δ,δ); the strongly corrugated digestive cavity (*St*), whose upper wall clings to the roof of the disk; inter-mouth frame muscle (*fm*); jaw (*c*).

Fig. 5 *Ophiocamax*, sp. nov. ♀, $\frac{4}{1}$. [Exp. of U. S. str. "Blake."] Vertical section of the disk passing through the sides of two arms. On either side is a genital bursa (δ,δ) emptying by the genital opening (*no*), and making a fold above over the digestive cavity (*St*), into which hang two more folds (δ,δ) which are cut through. Above the bursæ are pockets (δ',δ') containing embryos just beginning to develop. A larger view of one of these is given in fig. 4, Plate XLVI.; section of second mouth-tentacle (r''); wings of arm bones shaved by the section (w').

PLATE XLVIII.

Gorgonocephalus verrucosus, Lym. Diagram of the right stem, or half of an arm carried out to its last forks, $\frac{2}{3}$.

The figures indicate the order of forks as counted from the disk. Fork 1 is not seen, as it lies within and under the disk, just beyond whose margin is fork 2 of this right stem.

For observations on the mode of forking among Astrophytons, see Proceedings of the Boston Society of Natural History, vol. xix., March 7, 1877.

This plate is quite a monument of patience on the part of my assistant, Miss Clark. It is no fancy sketch, but a reduction of a large drawing, to make which every fine twig was separately unrolled and measured, so that not only is the number of forkings correct, but also the proportions of the parts.

I take this opportunity to acknowledge the skill and fidelity of my artists, Miss K. Peirson and Mr. L. Trouvelot, shown in the preparation of the original drawings and the plates.

INDEX.

Acantharachna mirabilis, E. A. Smith, 175.
Amphilepis, Ljn., 149.
norvegica, Ljn., 149, 286, 288, 314, 316, 317, 318, 321 (Pl. XI. fig. 19).
papyracea, Lym., 150, 301, 318, 323.
patens, Lym., 149, 306, 318, 321 (Pl. XIX. figs. 1–3).
tenuis, Lym., 151, 305, 318, 321.
Amphipholis albida, Ljn., 27.
andreæ, Ltk., 148.
antarctica, Ljn., 146.
appressa, Ljn., 136.
depressa, Ljn., 137.
elegans, Ltk., 136.
goësi, Ljn., 146.
grisea, Ljn., 146.
hastata, Ljn., 148.
impressa, Ljn., 148.
integra, Ljn., 148.
kinbergi, Ljn., 136.
kochii, Ltk., 146.
lineata, Ljn., 136.
lütkeni, Ljn., 147.
patagonica, Ljn., 145.
planispina, v. Mart., 146.
subtilis, Ljn., 146.
tenuispina, Ljn., 145.
torelli, Ljn., 145.
Amphiura, Fbs., 122.
abdita, Vll., 126, 148, 311.
abyssicola, Sars, 122.
acacia, Lym., 124, 130, 304, 317, 321 (Pl. XVI. figs. 15–17).
andreæ, Lym., 126, 148, 311, 324.
angularis, Lym., 123, 124, 134, 294, 314, 321 (Pl. XXIX. figs. 1–3).
anomala, Lym., 124, 144, 316.
antarctica Lym., 125, 146, 286, 311.
Amphiura antarctica, Studer, 128.
argentea, Lym., 124, 129, 298, 317, 322 (Pl. XVI. figs. 7–10).
atlantica, Ljn., 124, 144, 310.
atra, Ltk., 125, 147, 311, 324.
ballii, Sars, 121.
barbaræ, Lym., 125, 147, 311, 324.
bellis, Lym., 122, 123, 127, 299, 304, 316, 317, 321, 322 (Pl. XVIII. figs. 4–6; Pl. XI. figs. 16–18).
borealis, Lym., 124, 144, 314, 316.
candida, Ljn., 123, 142, 310, 324.
canescens, Lym., 126, 140, 298, 317, 323, (Pl. XVII. figs. 7–9).
capensis, Ljn., 124, 129, 291, 314, 322 (Pl. XVIII. figs. 14–16).
cernua, Lym., 126, 138, 305, 318, 321 (Pl. XVII. figs. 13–15).
chiajei, Fbs., 123, 142, 143, 314.
chilensis, Ltk., 125, 147, 311, 324.
complanata, Ljn., 123, 142, 316, 324.
concolor, Lym., 123, 125, 137, 300, 301, 317, 318, 321, 323 (Pl. XVII. figs. 1–3).
constricta, Lym. 124, 131, 296, 310, 324 (Pl. XVI. figs. 11–14).
cordifera, Ltk., 146, 158.
coreæ, Duncan, 125, 146, 314.
crassipes, Ljn., 123, 142, 314.
cuneata, Lym., 126, 148, 316.
dalea, Lym., 126, 137, 141, 308, 318, 321 (Pl. XVIII. figs. 11–13).
depressa, Lym., 126, 137, 286, 316, 324.
dilatata, Lym., 124, 135, 291, 314, 322, (Pl. XXIX. figs. 4–6).
divaricata, Ljn., 123, 142, 316, 324.
duncani, Lym., 124, 143, 310.
duplicata, Lym., 126, 136, 288, 314, 316, 317, 318, 321 (Pl. XVII. figs. 10–12).

Amphiura elegans, Norm., 136.
elongata, Ltk., 158.
eugeniæ, Ljn., 123, 143, 314.
filiformis, Fbs., 124, 144, 310, 314, 322.
fissa, Ltk., 125, 147, 311.
flexuosa, Ljn., 124, 144, 310, 324.
„ (?), Lym., 143.
florifera Fbs., 142.
geminata, Ltk., 125, 145, 311, 324.
gibbosa, Lym., 126, 148, 311.
glabra, Lym., 124, 134, 303, 316, 322 (Pl. XXXIII. figs. 8–10).
glauca, Lym., 126, 139, 304, 316, 321, 323 (Pl. XVIII. figs. 1–3).
goësii, Lym., 125, 146, 316.
gracillima, Ltk., 125, 146, 311, 324.
grandisquama, Lym., 124, 143, 310, 314, 316, 324.
grisea, Lym., 125, 146, 311, 324.
hastata, Lym., 126, 148, 311, 324.
(*Ophiolepis*) *hispida*, Ltk., 155.
holbölli, Ltk., 143.
impressa, Lym., 126, 148, 316, 324.
incana, Lym., 123, 128, 291, 310 (Pl. XXXIII. figs. 5–7; Pl. XLVI. fig. 5).
integra, Lym., 126, 148, 311.
iris, Lym., 124, 132, 304, 316, 317, 321 (Pl. XVI. figs. 4–6).
januarii, Ljn., 146.
josephinæ Ljn., 124, 131, 286, 316.
kinbergi, Ljn., 124, 144, 310.
kochii, Lym., 125, 146, 311.
lævis Lym., 126, 148, 311, 324.
lanceolata, Lym., 124, 133, 297, 317, 322 (Pl. XXIX. figs. 7–9).
latispina, Ljn., 124, 144, 310, 324.
limbata, Ltk., 125, 145, 311, 324,
lobata, Ljn., 126, 148, 311.
lunaris, Lym., 124, 144, 317.
lütkeni, Lym., 125, 147, 311, 324.
„ Duncan, 143.
magellanica, Ljn., 124, 143, 310.
marginata, Örst. & Ltk., 159.
maxima, Lym., 123, 126, 300, 310 (Pl. XVIII. figs. 7–10).
mediterranea, Lym., 123, 142, 324.
Amphiura microdiscus, Örst. & Ltk., 125, 145, 310, 324.
neapolitana, Sars, 155.
norvegica, Ljn., 149.
occidentalis, Lym., 125, 147, 314.
örstedii, Ltk., 125, 147, 311, 324.
otteri, Ljn., 123, 128, 286, 317, 318, 321, 322.
palmeri, Lym., 123, 143, 314.
parva, Hutton, 126.
patagonica, Lym., 125, 145, 311.
patula, Lym., 126, 141, 295, 318 (Pl. XVII. figs. 4–6).
perplexa, Lym., 124, 144, 310.
planispina, Lym., 125, 146, 311, 324.
pugetana, Lym., 125, 145, 311.
pulchella, Lym., 125, 147, 311, 314, 324.
puntarenæ, Örst. & Ltk., 125, 145, 311, 324.
repens, Lym., 125, 147, 311, 324.
riisei, Ltk., 125, 146, 311, 324.
sarsii, Ljn., 124, 144, 310, 314, 316, 317, 324.
scabriuscula, Ltk., 155.
securigera, Lym., 126, 148, 311.
semiermis, Lym., 124, 143, 316, 317.
septa, Ltk., 159.
squamata, Sars, 125, 136, 291, 296, 309, 310, 314, 321, 322, 324.
„ „ (var. ?) Ljn., 145.
stepanovii, Tscherniawsky, 142.
stimpsoni, Ltk., 124, 143, 310, 314, 324.
studeri, Lym., 123, 128, 291, 292, 293, 294, 310, 314, 316, 321.
subtilis, Lym., 125, 146, 311, 324.
sundevalli, Ljn., 124, 143, 310, 314, 322.
tenera, Ltk., 136.
tenuis, Lym., 136.
tenuispina, Ljn., 125, 145, 314, 316.
tomentosa, Lym., 124, 132, 310, 314 (Pl. XXIX. figs. 10–12).
torelli, Lym., 125, 145, 310, 322.
tumida, Lym., 126, 149, 316.
urtica, Lym., 125, 147, 311.
violacea, Örst. & Ltk., 125, 145, 311, 324.

Amphiura verrilli, Lym., 126, 139, 288, 318 (Pl. XVII. figs. 16–18).
verticillata, Ljn., 123, 142, 310, 324.
wurdemani, Lym., 159.
Asterias aculeata, Retz., 112.
„ Linn., 112.
„ Abildgaard, 112.
bidentata, Retz., 186.
brachiata, Montagu, 155.
caput medusæ, Dewhurst, 263.
„ Fabr., 263.
„ Linn., 263, 264.
ciliata, Retz., 76.
cordifera, Bosc, 158.
cordifera, Delle Chiaje, 76.
cuvieri, Delle Chiaje, 224.
echinata, Delle Chiaje, 224.
ferussaci, Delle Chiaje, 224.
filiformis, O. F. Müller, 144.
filiformis, Delle Chiaje, 142.
fragilis Abildg. (Müller), 224.
nigra, Abildgaard, 172.
oligactes, Pallas, 278.
ophiura, Fabr., 112.
„ Delle Chiaje, 10.
„ O. F. Müll., 76.
pentagona, Delle Chiaje, 224.
pentaphyllum, Pennant, 225.
quinquemaculata, Delle Chiaje, 225.
scutatum (pars), Linck, 264.
setosa, Retz., 198.
sphærulata, Pennant, 172.
squamata, Delle Chiaje, 136.
tenorii, Delle Chiaje, 77.
tricolor, Delle Chiaje, 224.
Asteromorpha lævis, Lym., 278.
steenstrupii, Ltk., 278
Asteroschema rousseavi, Michelin, 278.
Astroceras, Lym., 256, 284.
pergamena, Lym., 284, 304, 318, 322 (Pl. XXXIV. figs. 1–5).
Astrochele, Vll., 256, 271.
lymani, Vll., 272, 317, 318.
Astroclon, Lym., 256, 267.
propugnatoris, Lym., 267, 300, 315 (Pl. XXXIV. figs. 6–11).
Astrocnida, Lym., 256, 269, 315.
isidis, Lym., 269, 270, 315, 326 (Pl. XLVI. fig. 2).
Astrogomphus, Lym., 256, 271.
vallatus, Lym., 271, 315, 317 (Pl. XLIV. figs. 10–12).
Astromyæ, Müll. & Tr., 256, 285.
loveni, Müll. & Tr., 285, 288, 304, 315, 317, 322, 323.
Astrophyton, Linck, 251, 256.
agassizii, Stimp., 264.
arborescens, Müll. & Tr., 263.
asperum, Agas., 266.
australe, Vll., 265.
cacaoticum, Lym., 264.
caryi, Lym., 264.
chilense, Phil., 265.
clavatum, Lym., 256, 258, 313, 326.
cæcilia, Ltk., 256, 258, 315, 326.
costosum, Seba (non Linck), 256, 257, 266, 271, 290, 313, 326 (Pl. XXXV. figs. 17–25).
„ Agas., 263.
eucnemis, Müll. & Tr., 263.
exiguum, Agas., 256, 257, 300, 302, 313, 326 (Pl. XLVII. fig. 1).
krebsii, Örst. & Ltk., 258.
lævipelle, Grubbe, 266.
lamarckii, Müll. & Tr., 263.
linckii, Müll. & Tr., 264.
lymani, Bell, 261.
malmgrenii, D. C. Danielssen, 264.
mucronatum, Lym., 265.
muricatum, Agas., 257.
nudum, Lym., 256, 257, 313, 326.
palmiferum, Bronn, 267.
panamense, Vll., 256, 264, 313, 326.
pourtalesii, Lym., 261.
scutatum, Agas., 262.
„ (pars), Linck, 266.
scutatum scuto rotato, Linck, 264.
spinosum, Lym., 256, 257, 313, 326.
stimpsonii, Vll., 264.
verrucosum, Müll. & Tr., 262.
Astroporpa, Örst. & Ltk., 256, 270.
affinis, Ltk., 271, 315, 326.

Astroporpa annulata, Örst. & Ltk., 270, 315, 326.
dasycladia, Duj. & Hupé, 270.
Astroschema, Örst. & Ltk., 256, 273, 309.
arenosum, Lym., 274, 278, 318.
brachiatum, Lym., 274, 276, 287, 317 (Pl. XXX. figs. 5–8).
horridum, Lym., 274, 275, 297, 318, 323 (Pl. XXX. figs. 1–4).
intectum, Lym., 274, 278, 317.
lævе, Lym., 274, 276, 278, 313, 326.
oligactes, Ltk., 274, 278, 315, 317, 326 (Pl. XLIV. figs. 1–5).
rubrum, Lym., 274, 277, 307, 317, (Pl. XXXIII. figs. 1–4).
salix, Lym., 274, 277, 297, 318, 323 (Pl. XXII. figs. 12–15).
steenstrupii, Lym., 274, 278, 313.
sulcatum, Ljn., 274, 278, 317.
tenue, Lym., 274, 276, 278, 315, 326.
tumidum, Lym., 274, 275, 300, 315 (Pl. XXII. figs. 8–11).
Astrotoma, Lym., 256, 272.
agassizii, Lym., 272, 292, 306, 307, 315, 323.
murrayi, Lym., 272, 301, 317 (Pl. XXII. figs. 5–7).

Basket fish, J. Winthrop, 264.

Bellis scolopendrica, Linck, 112.

Capitis medusæ altera species minor supina, Seba, 266.

Euryale, Lmk., 251, 265.
aspera (*asperum*), Lmk., 266, 284, 299, 301, 313, 326 (Pl. XXXV. figs. 1–16; Pl. XLV. figs. 6–9).
costosum, Lmk., 263.
exiguum, Lmk., 257.
muricatum, Lmk., 257.
palmiferum, Lmk., 267.
scutatum, Gould (non De Blainville), 264.
verrucosum, Lmk., 262.

Gorgonocephalus, Leach, 251, 256, 258.
agassizii, Lym., 253, 261, 263, 264, 313, 323 (Pl. XXXV. fig. 26; Pl. XXXVI.).
arborescens, Agas., 261, 263, 313, 326.
australis, Lym., 261, 265, 313.
cacaoticus, Lym., 261, 264, 313, 326.
caryi, Lym., 261, 264, 313.
chilensis, Lym., 261, 265, 313.
eucnemis, Lym., 254, 261, 315, 323.
lamarckii, Lym., 261, 263, 313.
linckii, Lym., 261, 264, 313.
malmgrenii, Lym., 261, 264, 317.
mucronatus, Lym., 261, 265, 315.
pourtalesii, Lym., 258, 261, 293, 294, 306, 307, 309, 315, 322, 323 (Pl. XLV. figs. 2–5).
stimpsonii, Lym., 261, 264, 313.
verrucosus, Lym., 261, 262, 291, 313, 326 (Pl. XLVIII.).

Hemipholis, Agas., 157.
affinis, Ljn., 158.
cordifera, Lym., 157, 158, 311, 324 (Pl. XL. figs. 8–12; Pl. XLIV. figs. 13–16).
elongata, Agas., 158.
gracilis, Vll., 158, 311, 324.
microdiscus, Duncan, 158, 314.
wallichii, Duncan, 158.
Hemieuryale, v. Mart., 248.
„ *pustulata*, v. Mart., 249, 254, 315, 317, 326 (Pl. XLIII. figs 7–10).

Lütkenia arctica, Duncan, 31.

Ophiacantha, Müll. & Tr., 178, 286.
abnormis, Lym., 178, 179, 189, 302, 316, 317, 323 (Pl. XXVI. figs. 4–6).
abyssicola, G. O. Sars, 180, 199, 312, 314, 316, 323.
anomala, G. O. Sars, 179, 187, 198, 316.
aspera, Lym., 180, 199, 316.
bidentata, Ljn., 178, 179, 181, 186, 288, 312, 314, 316, 317, 318, 319, 321.
chelys, Wyv. Thom., 205.
cornuta, Lym., 180, 193, 297, 298, 317, 323 (Pl. XV. figs. 3–5).

Ophiacantha cosmica, Lym., 180, 194, 195, 196, 290, 292, 294, 295, 300, 303, 305, 306, 309, 316, 317, 319, 322, 323, (Pl. XIII. figs. 13–15).
cuspidata, Lym., 180, 191, 308, 316 (Pl. XV. figs. 9–10; Pl. XLI. figs. 12–14).
dallasii, Duncan, 180, 199, 314.
discoidea, Lym., 180, 196, 300, 314, 325 (Pl. XXVI. figs 1–3).
echinulata, Lym., 179, 198, 317.
granulosa, Lym., 178, 179, 183, 301, 314 (Pl. XIV. figs. 7–9).
grönlandica, Müll. & Tr., 186.
hirsuta, Lym., 179, 190, 198, 314, 316, 325.
imago, Lym., 179, 186, 293, 294, 312, 314, 322 (Pl. XXV. figs. 4–6).
indica, Ljn., 180, 199, 316, 325.
levispina, Lym., 180, 196, 303, 316, 323 (Pl. XXV. figs. 1–3).
longidens, Lym., 180, 192, 302, 314, 325 (Pl. XXV. figs. 7–9).
marsupialis, Lym., 180, 199, 316.
meridionalis, Lym., 199.
millespina, Vll., 180, 195, 198, 316.
nodosa, Lym., 180, 192, 287, 318 (Pl. XXII. figs. 1–4).
normani, Lym., 208.
pentacrinus, Ltk., 178, 180, 199, 286, 314, 316, 317, 325.
placentigera, Lym., 179, 181, 299, 318, 321 (Pl. XXVIII. figs. 15–17).
rosea, Lym., 179, 184, 291, 304, 306, 314, 316, 317, 321 (Pl. XXV. figs. 10–12).
scabra, Sars, 198.
scutata, Lym., 180, 199, 316.
segesta, Lym., 179, 188, 189, 288, 318, 322 (Pl. XV. figs. 1–2).
sentosa, Lym., 179, 187, 305, 318, 322 (Pl. XIII. figs. 10–12).
serrata, Lym., 180, 195, 197, 303, 314, (Pl. XV. figs. 6–8).
sertata, Lym., 179, 198, 316.
Ophiacantha setosa, Müll. & Tr., 179, 191, 198, 314, 325.
smitti, Ljn., 179, 198, 317.
spectabilis, G. O. Sars, 179, 198, 314.
spinulosa, Müll. & Tr., 186.
stellata, Lym., 180, 199, 314, 325.
stimulea, Lym., 179, 188, 296, 317, 322 (Pl. XIII. figs. 4–6).
troscheli, Lym., 179, 190, 287, 314, 316, 325 (Pl. XIII. figs. 1–3).
tuberculosa, Lym., 179, 181, 302, 316, 323 (Pl. X. figs. 1–3).
valenciennesi, Lym., 179, 183, 300, 314 (Pl. XXVI. figs. 7–8).
vepratica, Lym., 179, 182, 298, 317, 323 (Pl. XIII. figs. 7–9).
vivipara, Ljn., 41, 178, 179, 181, 185, 292, 293, 294, 307, 308, 309, 312, 314, 316, 317, 321, 323 (Pl. XLVI. figs. 7–9).
Ophiactis, Ltk., 112, 286.
abyssicola, Ljn., 114, 122, 316.
affinis, Duncan, 113, 121, 310.
arenosa, Ltk., 114, 122, 310, 324.
asperula, Ltk., 113, 114, 116, 306, 307, 314, 316.
atacamensis, Ljn., 122.
ballii, Ltk., 113, 114, 121, 314.
canotia, Lym., 114, 119, 156, 289, 318, 322 (Pl. XIX. figs. 16–18).
carnea, Ljn., 114, 120, 291, 310, 324.
clavigera, Ljn., 200, 201.
cuspidata, Lym. 113, 114, 117, 121, 297, 298, 317, 322 (Pl. XX. figs. 10–12).
flexuosa, Lym., 113, 116, 291, 298, 314, 316, 317, 322 (Pl. XX. figs. 1–3).
fragilis, Ljn., 122.
hirta, Lym., 114, 118, 296, 316 (Pl. XX. figs. 4–6).
humilis, Lym., 202.
incisa, v. Mart., 115.
krebsii, Ltk., 115.
kröyeri, Ltk., 113, 114, 122, 310, 324.
loricata, Lym., 113, 121, 310, 314, 324.
lymani, Ljn., 113, 121, 314, 324.
maculosa, v. Mart., 114, 122, 310, 324.

Ophiactis magellanica, Ljn., 116.
mülleri, Ltk., 113, 115, 116, 290, 310, 314, 316.
nama, Lym., 114, 117, 298, 299, 316, 317, 322 (Pl. XX. figs. 16–18).
nigrescens, Hutt., 114, 122, 310, 324.
örstedii, Ltk., 122.
pectorale, Lym., 114, 120, 303, 316 (Pl. XXVII. figs. 4–6).
plana, Lym., 113, 116, 121, 310, 314, 324.
poa, Lym., 114, 119, 290, 317, 318 (Pl. XX. figs. 13–15).
reinhardti, Ltk., 115.
resiliens, Lym., 113, 115, 296, 310, 314, 324 (Pl. XX. figs. 7–9).
savignyi, Ljn., 113, 115, 302, 303, 310, 324.
sexradia, Ltk., 115.
simplex, Ltk., 114, 122, 310, 324.
virens, Sars, 113, 121, 310, 324.
virescens, Örst. & Ltk., 115.
Ophiambix, Lym., 234.
aculeatus, Lym., 235, 299, 319, 322 (Pl. XXVII. figs. 10–12).
Ophianoplus annulosus, Sars, 160.
marmoreus, Sars, 160.
Ophiaregma, G. O. Sars, 156.
abyssorum, G. O. Sars, 156.
Ophiarachna, Müll. & Tr., 173.
affinis, Ltk., 173, 312, 325.
armata, Troschel., 173, 312, 325.
incrassata, Müll. & Tr., 173, 312, 325.
infernalis, Müll & Tr., 17.
gorgonia, Müll. & Tr., 15.
septemspinosa, Müll. & Tr., 17.
spinosa, Ljn., 17.
stellata, Ljn., 15.
vestita, Lym., 17.
Ophiarachnella stellata, Ljn., 15.
Ophiarthrum, Pet., 173.
elegans, Pet., 174, 312, 325.
pictum, Lym., 174, 312, 325.
Ophiernus, Lym., 31.
vallincola, Lym., 32, 289, 292, 295, 318. 321 (Pl. XXIV. figs. 16–18; Pl. XXXVIII. figs. 6–9).
Ophioblenna, Ltk., 231.
antillensis, Ltk. 232, 313, 326.
Ophiobyrsa, Lym., 243.
rudis, Lym., 244, 295, 315 (Pl. XVI. figs. 18–20; Pl. XLIII. figs. 16–18).
Ophiocamax, Lym., 209 (Pl. XLVI. fig. 4; Pl. XLVII. fig. 5).
hystrix, Lym., 211, 316 (Pl. XLI. figs. 9–11).
vitrea, Lym., 210, 300, 301, 302, 303, 314, 316, 325 (Pl. XIV. figs. 10–12).
Ophiocentrus, Ljn., 167.
Ophiocentrus aculeatus, Ljn., 167, 316, 325.
Ophioceramis, Lym., 25.
albida, Lym., 27, 310, 313, 324.
(?) *clausa*, Lym., 26, 297, 298, 317, 322 (Pl. XI. figs. 4–6).
januarii, Lym., 27, 313, 324 (Pl. XXXVII. figs. 16–18).
(?) *obstricta*, Lym., 26, 297, 300, 313 (Pl. XI. figs. 1–3).
Ophiochasma (*Ophiolepis*) *adsperum*, Grube, 15.
Ophiochiton, Lym., 176.
Ophiochiton fastigatus, Lym., 176, 300, 304, 316, 323 (Pl. XXIV. figs. 13–15).
Ophiochiton lentus, Lym., 177, 297, 317, 323 (Pl. XXIII. figs. 16–18).
Ophiochoeta, Ltk., 109.
(?) *mixta*, Lym., 109, 110, 316 (Pl. XXXIX. figs. 15–17).
setosa, Ltk., 110, 298, 310, 324.
Ophiochondrus, Lym., 245, 247.
convolutus, Lym., 248, 317 (Pl. XLIII. figs. 11–15).
stelliger, Lym., 247, 308, 318, 322 (Pl. XXI. figs. 13–15).
Ophiochytra. Lym., 166.
epigrus, Lym., 166, 305, 318, 321 (Pl. XXVIII. figs. 12–14).
Ophiocnemis, Müll. & Tr., 228.
marmorata, Müll. & Tr., 229, 312, 326 (Pl. XLII. figs. 14–15).
obscura, Ljn., 230.
Ophiocnida, Lym., 152.
abyssicola, Lym., 122.
abnormis, Lym., 153, 155, 314.

Ophiocnida ballii, Lym., 121.
brachiata, Lym., 153, 155, 311, 323, 324.
caribea (?), Ljn., 153, 155, 316.
echinata, Lym., 153, 155, 311, 324.
filogranea, Lym., 153, 155, 311, 324.
hispida, Lym., 153, 155, 311, 324.
loveni, Lym., 153, 155, 311, 324.
neapolitana, Lym., 155.
olivacea, Lym., 153, 156, 314.
pilosa, Lym., 153, 296, 302, 311, 314, 324 (Pl. XIX. figs. 7–9).
putnami, Lym., 153, 156, 311, 324.
scabra, Lym., 153, 154, 290, 318 (Pl. XIX. figs. 4–6).
scabriuscula, Lym., 153, 155, 311, 324.
Ophiocnidella scabriuscula, Ljn., 155.
Ophiocoma, Agas., 167, 286.
æthiops, Ltk., 168, 170, 171, 311, 325 (Pl. XLII. figs. 9–11).
alexandri, Lym., 170, 172, 311, 325.
alternans (young?), v. Mart., 170.
arctica, Müll. & Tr., 186.
ballii, Thomp., 121.
bellis, Fbs., 112.
brachiata, Fbs., 155.
brevipes, Pet., 169, 172, 311, 325.
brevispinosa, E. A. Smith, 172.
canaliculata, Ltk., 168, 170, 172, 311.
crassispina, Müll. & Tr., 171.
echinata, Agas., 168, 169, 171, 287, 311, 325 (Pl. XLII. figs. 12–13).
echinulata, Fbs., 186.
erinaceus, Müll. & Tr., 168, 169, 170, 302, 305, 311, 325.
filiformis, Fbs., 144.
goodsiri, Fbs., 121.
granulata, Fbs., 172.
insularia, Lym., 172.
lineolata, Müll. & Tr., 171.
molaris, Lym., 170.
neglecta, Fbs., 136.
nigra, Müll. & Tr., 167, 168, 169, 170, 172, 311, 323.
nilsonii, Müll. & Tr., 172.
ocellata, v. Mart., 173.
Ophiocoma papillosa, Lym., 168, 170, 173, 311, 325.
pica, Müll. & Tr., 168, 169, 171, 301, 311, 325.
picta, Müll., & Tr., 174.
pumila, Ltk., 168, 170, 171, 288, 311, 325.
raschii, G. O. Sars, 170, 172, 314.
riisei, Ltk., 168, 170, 171, 311, 325.
rosula, Fbs., 225.
sannio, Lym., 171.
schoenleinii, Müll. & Tr., 169, 171, 311.
scolopendrina, Agas., 168, 169, 170, 266, 291, 298, 302, 311, 325 (Pl. XLVII. fig. 3).
serpentaria, Müll. & Tr., 171.
squamata, Agas., 169, 172, 311, 325.
tartarea, Lym., 170.
ternispina, V. Martens, 172.
tumida, Müll. & Tr., 171.
valenciæ, Müll. & Tr., 170, 172, 311, 325.
variegata, E. A. Smith, 172.
viripara, Wyv. Thom., 185.
wendtii, Müll. & Tr., 169, 171, 311.
Ophioconis, Ltk., 106.
antarctica, Lym., 107, 168, 291, 292, 294, 314, 321 (Pl. XXIII. figs. 1–3).
brevispina, Ludwig, 107, 109, 310, 324.
forbesii, Ltk., 107, 109, 169, 310, 314, 324.
miliaria, Lym., 106, 107, 109, 168, 316 (Pl. XXXIX. figs. 7–9).
pulverulenta, Lym., 107, 108, 298, 316 (Pl. XXIII. figs. 4–6).
Ophiocreas, Lym., 256, 279.
abyssicola, Lym., 280, 282, 305, 319, 322 (Pl. XXXII. figs. 1–4).
carnosus, Lym., 280, 281, 306, 317 (Pl. XXXI. figs. 1–4).
caudatus, Lym., 280, 281, 304, 317, 323 (Pl. XXXII. figs. 5–8).
lumbricus, Lym., 280, 284, 315, 317, 326.
œdipus, Lym., 276, 280, 283, 286, 303, 308, 317, 323 (Pl. XXXI. figs. 5–8; Pl. XLVI. fig. 1).
Ophiocten, Ltk., 72, 78.

Ophiocten abyssicolum, Ltk., 78, 83, 313, 315.
amitinum, Lym., 78, 79, 292, 294, 295, 318, 321 (Pl. IX. figs. 7–9).
depressum, Lym., 78, 83, 315.
hastatum, Lym., 78, 82, 289, 292, 297, 318, 321 (Pl. IX. figs. 10–11).
kröyeri, Ltk., 79.
pallidum, Lym., 78, 80, 83, 295, 318, 321 (Pl. IX. figs. 4–6).
sericeum, Ljn., 78, 79, 292, 310, 313, 322 (Pl. XXXVIII. figs. 18–21).
umbraticum, Lym., 78, 81, 308, 318, 321 (Pl. IX. figs. 1–3).
Ophiocymbium, Lym., 162.
cavernosum, Lym., 163, 295, 318, 321 (Pl. XXVII. figs. 1–3).
Ophioderma antillarum, Ltk., 9.
brevicauda, Ltk., 9.
cinereum, Müll & Tr., 9.
elaps, Ltk., 11.
guttata, Ltk., 9.
januarii, Ltk., 10.
longicauda, Müll & Tr., 10.
olivaceum, Ayres, 9.
panamensis, Ltk., 10.
rubicunda, Ltk., 10.
serpens, Ltk., 9.
squamosissima, Ltk., 11.
tongana, Ltk., 9.
variegata, Ltk., 10.
virescens, Ltk., 9.
wahlbergii, Müll & Tr., 10.
Ophiogeron, Lym., 236.
edentulus, Lym., 237, 289, 299, 319, 322, 323 (Pl. XII. figs. 16–18).
Ophioglypha, Lym., 19, 34, 39, 78, 286.
acervata, Lym., 35, 39, 290, 313, 315, 324.
æqualis, Lym., 36, 45, 303, 318, 321 (Pl. IV. figs. 14, 15).
affinis, Lym., 35, 77, 310, 313, 315, 322, 324.
albata, Lym., 36, 51, 304, 317, 321 (Pl. V. figs. 13–15).
albida, Lym., 35, 44, 45, 76, 310, 313, 315, 322, 324.
Ophioglypha ambigua, Lym., 36, 54, 293, 310, 313 (Pl. VIII. figs. 4, 5).
arctica, Lym., 35, 76, 310, 313.
brevispina, E. A. Smith, 36, 53, 54, 293, 310, 313.
bullata, Wyv. Thom., 35, 37, 44, 57, 288, 289, 290, 318, 321 (Pl. XXXVIII. figs. 14–17).
carnea, Lym., 35, 76, 313, 315.
ciliata, Ljn., 35, 76, 310, 313, 322, 324.
confragosa, Lym., 38, 74, 308, 317, 321 (Pl. VIII. figs. 7–9).
convexa, Lym., 37, 58, 305, 308, 318, 321 (Pl. VI. figs. 13–15).
costata, Lym., 36, 50, 291, 313, 322 (Pl. V. figs. 1–3).
deshayesi, Lym., 38, 72, 293, 294, 313, 321 (Pl. VII. figs. 13–15; Pl. XXXVIII. figs. 22–25).
elevata, Lym., 37, 57, 291, 315 (Pl. V. figs. 16–18).
falcifera, Lym., 35, 42, 287, 315.
ferruginea, Lym., 38, 39.
flagellata, Lym., 35, 42, 304, 315, 322, (Pl. IV. figs. 16–18).
forbesii, Duncan, 35, 77, 313.
fraterna, Lym., 36, 56, 295, 318, 321 (Pl. VIII. fig. 6).
gracilis, G. O. Sars, 79.
hexactis, E. A. Smith, 34, 37, 41, 292, 293, 310, 313 (Pl. XLV. fig. 1; Pl. XLVII. fig. 2).
imbecillis, Lym., 36, 46, 304, 315, 322 (Pl. IV. figs. 11–13).
inermis, Lym., 38, 71, 72, 290, 315 (Pl. VII. figs. 4–6).
inornata, Lam., 38, 73, 289, 318, 321 (Pl. III. figs. 10–12).
irrorata, Lym., 36, 47, 286, 291, 315, 317, 318, 321 (Pl. V. figs. 7–9).
intorta, Lym., 38, 75, 292, 313 (Pl. VIII. figs. 13–15).
jejuna, Lym., 36, 52, 290, 296, 315 (Pl. V. figs. 4–6).
kinbergii, Ljn., 35, 38, 39, 295, 296, 300, 310, 313 (Pl. IV. fig. 7.)

Ophioglypha lacazei, Lym., 37, 62, 295, 306, 318, 321 (Pl. VI. figs. 4–6).
lacertosa, Lym., 76.
lapidaria, Lym., 37, 66, 304, 317, 321, (Pl. VII. figs. 16–18).
lepida, Lym., 36, 43, 44, 45, 46, 288, 289, 308, 315, 317, 318, 321, 322 (Pl. IV. figs. 1–3).
lienosa, Lym., 37, 63, 295, 318, 321 (Pl. VI. figs. 7–9).
ljungmani, Lym., 36, 44, 290, 315 (Pl. IV. figs. 8–10).
loveni, Lym., 36, 55, 56, 292, 295, 318, 321 (Pl. VIII. figs. 1–3).
lütkeni, Lym., 35, 76, 310, 313.
lymani, Ljn., 36, 47, 50, 306, 307, 313, 315, 322 (Pl. XXXVIII. figs. 10–13).
meridionalis, Lym., 35, 40, 308, 317, 318, 321.
minuta, Lym., 38, 70, 292, 295, 318, 321 (Pl. VII. figs. 10–12).
multispina, Ljn., 38, 41, 296, 313.
nodosa, Lym., 37, 78, 310, 313, 322.
orbiculata, Lym., 36, 48, 305, 318, 321 (Pl. VIII. figs. 10–12).
ornata, Lym., 37, 61, 286, 296, 303, 318, 321 (Pl. VI. figs. 1–3).
palliata, Lym., 35, 43, 296, 315, 317, 318 (Pl. IV. figs. 4–6).
ponderosa, Lym., 38, 69, 304, 315, 322 (Pl. VII. figs. 7–9).
radiata, Lym., 37, 64, 302, 318, 321 (Pl. VII. figs. 1–3).
robusta, Lym., 35, 41, 77, 310, 313, 322.
rugosa, Lym., 38, 68, 297, 317, 322 (Pl. III. figs. 13–15).
sarsii, Lym., 35, 40, 76, 288, 310, 313, 315, 321, 322.
sculpta, Duncan, 37, 77, 310.
sculptilis, Lym., 37, 59, 305, 318, 321 (Pl. VI. figs. 16–18).
sinensis, Lym., 35, 38, 39, 304, 305, 310, 324.
sladeni, Duncan, 37, 77, 310.
Ophioglypha striata, Duncan, 37, 77, 310.
solida, Lym., 38, 67, 300, 313 (Pl. III. figs. 7–9).
stuwitzii, Lym., 37, 77, 310, 322.
tenorii, Ljn., 77.
undata, Lym., 37, 65, 299, 318, 321 (Pl. III. figs. 16–18).
undulata, Lym., 36, 49, 303, 318, 321 (Pl. V. figs. 10–12).
variabilis, Lym., 37, 60, 287, 301, 315, 317, 318, 321 (Pl. VI. figs. 10–12).
Ophiogona, Studer, 18.
lævigata, Studer, 18, 313.
Ophiogymna, Ljn., 228.
elegans, Ljn., 228, 301, 312, 326.
Ophiohalus, Lym., 237.
pellucidus, Lym., 237, 299, 319, 322 (Pl. XXVIII. figs. 5–9).
umbella, Lym., 238, 315, 326 (Pl. XXVIII. figs. 10–11).
Ophiolebes, Lym., 199.
claviger, Lym., 201, 316.
humilis, Lym., 202, 314, 316.
scorteus, Lym., 200, 291, 292, 316, 318, 319, 322 (Pl. XLI. fig. 8; Pl. XII. figs. 7–9).
vestitus, Lym., 201, 306, 307, 314, 316, 323 (Pl. XII. figs. 10–12).
Ophiolepis, Müll. & Tr., 18, 25, 84.
annulata, Le Conte, 162.
annulosa, Müll. & Tr., 19, 299, 301, 310, 323.
asperula, Phil., 116.
atacamensis, Phil., 122.
atra, Stimp., 147.
ballii, Müll. & Tr., 121.
carinata, Studer, 19, 20, 313.
chilensis, Müll. & Tr., 147.
ciliata, Müll. & Tr., 40, 76.
cincta, Müll. & Tr., 19, 299, 303, 310, 323 (Pl. XXXVII. figs. 7–9).
dubia, Müll. & Tr., 161.
elegans, Ltk., 19, 20, 310, 323.
elongata, Müll. & Tr., 158.
filiformis, Müll. & Tr., 144.
garretti, Lym., 19.

Ophiolepis geminata, Le Conte, 145.
gracillima, Stimp., 146.
hispida, Le Conte, 155.
imbricata, Müll. & Tr., 20.
impressa, Ltk., 21.
januarii, Ltk., 27.
limbata, Grube, 145.
mirabilis, Duncan, 111, 112.
nereis, Ltk., 162.
pacifica, Ltk., 25.
paucispina, Müll. & Tr., 19, 310, 323.
perplexa, Stimp., 144.
robusta, Ayr., 77.
savignyi, Müll. & Tr., 115.
schayeri, Müll. & Tr., 162.
(*Ophiopholis*) *scolopendrica*, Müll. & Tr., 112.
sexradia, Grube, 115.
simplex, Le Conte, 122.
(*Amphiura*) *squamata*, Sars, 136.
squamata, Müll. & Tr., 136.
sundevalli, Müll. & Tr., 143.
tenorii, Müll. & Tr., 77.
tenuis, Ayr., 136.
triloba, Ltk., 162.
uncinata, Ayres, 158.
variegata, Ltk., 19, 20, 310, 323.
Ophiolipus, Lym., 99.
agassizii, Lym., 100, 314 (Pl. XXXIX. figs. 1–3).
Ophiomastix, Müll. & Tr., 174, 286.
annulosa, Müll. & Tr., 174, 175, 312, 325.
asperula, Ltk., 175, 312, 325.
caryophyllata, Ltk., 174, 175, 302, 312, 325.
flaccida, Lym., 175, 312, 325.
janualis, Lym., 174, 175, 312, 325.
mixta, Ltk., 174, 175, 298, 312, 325.
venosa, Pet., 174, 175, 312, 325.
Ophiomastus, Lym., 100, 286.
secundus, Lym., 101, 315 (Pl. XXXIX. fig. 14).
tegulitius, Lym., 100, 296, 297, 303, 315, 317, 318, 321, 322 (Pl. VIII. figs. 16–18).
Ophiomaza, Lym., 229.
Ophiomaza cacaotica, Lym., 229, 300, 312, 326.
obscura, Lym., 230, 312, 326.
Ophiomitra, Lym., 202, 286.
carduus, Lym., 202, 206, 289, 319 (Pl. XIV. figs. 4–6).
cervicornis, Lym., 209.
chelys, Lym., 202, 205, 287, 289, 316, 318, 319.
dipsacos, Lym., 202, 207, 287, 316 (Pl. X. figs. 4–6).
exigua, Lym., 202, 209, 316.
normani, Lym., 202, 208, 304, 316, 318, 322, 323 (Pl. XXVI. figs. 9–11).
plicata, Lym., 202, 203, 204, 205, 297, 302, 303, 316, 318, 319, 322, 323 (Pl. X. figs. 7–9).
sarsii, Lym., 202, 204, 292, 319, 322 (Pl. X. figs. 10–12).
sertata, Lym., 198.
valida, Lym., 202, 209, 312, 314, 325 (Pl. XLI. figs. 4–6).
Ophiomusium, Lym., 83.
acuferum, Lym., 85, 92, 99, 313, 315.
archaster, Wyv. Thom., 84, 89, 308, 318, 321 (Pl. II. figs. 4–6).
armigerum, Lym., 84, 86, 289, 306, 308, 318, 321 (Pl. II. figs. 7–9).
cancellatum, Lym., 84, 88, 287, 304, 315, 321 (Pl. II. figs. 16–18).
corticosum, Lym., 84, 87, 303, 318, 321 (Pl. II. figs. 13–15).
eburneum, Lym., 84, 86, 99, 315.
flabellum, Lym., 84, 85, 98, 156, 296, 310, 314 (Pl. III. figs. 4–6).
granosum, Lym., 85, 96, 305, 318, 321 (Pl. I. figs. 10–12).
laqueatum, Lym., 85, 90, 300, 313 (Pl. II. figs. 10–12).
lunare, Lym., 85, 94, 303, 314 (Pl. I. figs. 13–15).
lütkeni, Lym., 85, 91, 300, 314 (Pl. I. figs. 16–18).
lymani, Wyv. Thom., 85, 90, 288, 289, 290, 297, 300, 304, 305, 309, 317, 318, 321, 322.
planum, Lym., 85, 99, 317.

Ophiomusium pulchellum, Wyv. Thom., 84, 85, 96, 99, 156, 289, 290, 291, 315, 317, 318, 322 (Pl. III. figs. 1–3).
scalare, Lym., 85, 95, 297, 317, 322 (Pl. I. figs. 4–6).
serratum, Lym., 84, 85, 287, 315, (Pl. II. figs. 1–3; Pl. XXXIX. fig. 10).
simplex, Lym., 85, 93, 301, 314 (Pl. I. figs. 7–9).
testudo, Lym., 85, 99, 314, 315.
validum, Ljn., 85, 92, 287, 309, 315, 317, 318 (Pl. I. figs. 1–3; Pl. XXXIX. figs. 11–13).
Ophiomyces, Lym., 240.
frutectosus, Lym., 239, 243, 315, 316, 326 (Pl. XLIV. figs. 6–9).
grandis, Lym., 241, 290, 318 (Pl. XIX. figs. 13–15).
mirabilis, Lym., 242, 316.
spathifer, Lym., 240, 304, 318, 322 (Pl. XIX. figs. 10–12).
Ophiomyxa, Müll. & Tr., 244.
australis, Ltk., 245, 246, 289, 295, 296, 298, 301, 313, 315, 317, 326.
caribœa, Ltk., 246.
flaccida, Ltk., 245, 246, 287, 290, 313, 315, 317, 326 (Pl. XLIII. figs. 1–3).
pentagona, Müll. & Tr., 245, 246, 254, 313, 326.
vivipara, Studer, 245, 246, 291, 306, 307, 315, 317, 323.
Ophionema, Ltk., 151.
intricata, Ltk., 152, 311, 324.
Ophionephthys, Ltk., 152.
limicola, Ltk., 152, 311, 324.
phalerata, Lym., 152, 311, 324.
Ophionereis, Ltk., 160.
albomaculata, E. A. Smith, 161, 162, 311.
annulata, Lym., 160, 161, 162, 311, 314, 325.
crassispina, Ljn., 161.
dubia, Lym., 161, 286, 299, 311, 325.
fasciata, Hutt., 162.
porrecta, Lym., 161, 162, 305, 311, 314, 325.
Ophionereis reticulata, Ltk., 160, 161, 162, 288, 290, 311, 314, 325 (Pl. XL. figs. 13–15).
schayeri, Ltk., 161, 162, 286, 296, 311, 325.
squamata, Ljn., 162.
variegata, Duncan, 162.
xantusii, Lym., 162.
Ophiopœpale, Ljn., 17.
goësiana, Ljn., 18, 313, 315 (Pl. XXXVII. figs. 4–6).
Ophiopeza, Pet., 11, 14, 16.
æqualis, Lym., 11, 12, 303, 313 (Pl. XXVII. figs. 7–8).
aster, Lym., 11, 12, 13, 291, 313, 322 (Pl. XXI. figs. 16–18).
fallax, Pet., 11, 13, 309, 323 (Pl. XLI. figs. 1–3).
petersi, Lym., 11, 13, 315.
yoldii, Ltk., 11, 12, 13, 286, 309, 323.
Ophiopezella spinosa, Ljn., 17.
Ophiopelta borealis, G. O. Sars, 144.
securigera, Düb. & Kor., 148.
Ophiopholis (*Ophiolepis*), Müll. & Tr., 110.
aculeata, Gray, 110, 111, 112, 288, 310, 314, 316, 321, 322 (Pl. XLVI. fig. 6).
bellis, Lym., 112.
caryi, Lym., 110, 112, 310.
japonica, Lym., 110, 111, 304, 316, 317, 321 (Pl. XXIII. figs. 13–15).
kennerlyi, Lym., 110, 112, 310.
mirabilis, Lym., 110, 111, 112, 310.
Ophiophragmus, Lym., 158.
antarcticus, Ljn., 146.
echinatus, Ljn., 155.
gibbosus, Ljn., 148.
loveni, Ljn., 155.
marginatus, Lym., 159, 311, 324.
septus, Lym., 159, 314, 324.
wurdemani, Lym., 158, 159, 168, 311, 324 (Pl. XL. figs. 4–7).
Ophiophyllum, Lym., 102, 286.
petilum, Lym., 102, 297, 298, 317, 322 (Pl. XII. figs. 13–15).
Ophioplax, Lym., 163.

Ophioplax ljungmani, Lym., 164, 314, 325 (Pl. XLI. fig. 7).
Ophiopleura, Danielssen, 31.
arctica, Duncan, 31, 317.
borealis, Danielssen, 31, 317.
Ophioplinthus, Lym., 28.
grisea, Lym., 30, 295, 318, 321 (Pl. XXIV. figs. 10–12).
medusa, Lym., 29, 295, 318, 321 (Pl. XXIV. figs. 7–9; Pl. XXXVIII. figs. 1–5).
Ophioplocus, Lym., 20.
esmarki, Lym., 20, 310, 324.
imbricatus, Lym., 20, 310, 323 (Pl. XXXVII. figs. 10–12).
tessellatus, Lym., 20.
Ophiopsammium, Lym., 231.
semperi, Lym., 231, 313, 326.
Ophiopsammus yoldii, Ltk., 12.
Ophiopsila, Fbs., 159.
annulosa, Ltk., 160, 311, 324.
aranea, Fbs., 160, 311, 314, 324.
fulva, Lym., 160, 311, 314, 316, 325.
marmorea, Ltk., 160.
riisei, Ltk., 160, 311, 314, 325 (Pl. XL. figs. 1–3).
Ophiopteris, E. A. Smith, 176.
antipodum, E. A. Smith, 168, 176, 312.
Ophiopyren, Lym., 104.
brevispinus, Lym., 105, 298, 315 (Pl. XII. figs. 1–3).
longispinus, Lym., 105, 287, 315 (Pl. XII. figs. 4–6; Pl. XXXIX. figs. 4–6).
Ophiopyrgus, Lym., 33.
wyville-thomsoni, Lym., 33, 298, 315 (Pl. IX. figs. 15–17).
Ophiopus, Ljn., 156.
arcticus, Ljn., 156, 311, 316, 323.
Ophiosciasma, Lym., 235.
attenuatum, Lym., 236, 290, 316 (Pl. X. fig. 13; Pl. XVI. figs. 1–3).
Ophioscolex, Müll. & Tr., 232, 234.
coppingeri, Bell., 232, 234.
dentatus, Lym., 232, 233, 291, 315 (Pl. XXIV. figs. 4–6).
Ophioscolex glacialis, Müll. & Tr., 232, 234, 315, 316 (Pl. XLII. figs. 2–4).
purpureus, Düb. & Kor., 232, 234, 316.
stimpsonii, Lym., 232, 234, 316.
tropicus, Lym., 232, 233, 287, 316 (Pl. XXIV. figs. 1–3).
Ophiostigma, Ltk., 164.
africanum, Lym., 165, 289, 311, 325 (Pl. XVIII. figs. 17–19).
formosa, Ltk., 165, 166, 311, 325.
isacanthum, Lym., 165, 311, 314, 325 (Pl. XLII. fig. 16).
moniliforme, Ltk., 165.
tenue, Ltk., 166, 311, 325.
Ophiothamnus, Lym., 211, 286.
affinis, Ljn., 213, 318.
remotus, Lym., 212, 291, 314, 323 (Pl. XIV. figs. 1–3).
vicarius, Lym., 212, 213, 266, 287, 312, 314, 325 (Pl. XLII. fig. 1).
Ophiothela, Vll., 230.
danæ, Vll., 230, 312, 326.
dividua, v. Mart., 230, 231, 312.
isidicola, Ltk., 230, 231, 312, 326.
mirabilis, Vll., 230, 312, 326.
tigris, Lym., 230, 312.
verrilli, Duncan, 231, 312.
Ophiotholia, Lym., 238.
supplicans, Lym., 239, 305, 319, 322 (Pl. XXVIII. figs. 1–4).
Ophiothrix, Müll. & Tr., 213.
alba, Grube, 224.
alopecurus, Müll. & Tr., 214, 215, 225, 312, 325.
angulata, Ayres, 214, 216, 218, 219, 286, 287, 290, 312, 315, 325.
aristulata, Lym., 218, 223, 291, 295, 296, 315, 323 (Pl. XXI. figs. 9–12).
aspidota, Müll. & Tr., 217, 227, 312, 325.
berberis, Lym., 216, 221, 300, 302, 315, 325 (Pl. XXI. figs. 1–4).
cæspitosa, Lym., 216, 218, 296, 312 (Pl. XXVI. figs. 12–14).
capensis, Ltk., 218, 224, 228, 312.

Ophiothrix capillaris, Lym., 218, 222, 301, 302, 315, 326 (Pl. XXI. figs. 5–8).
caribœa, Ltk., 219.
carinata, v. Mart., 217, 227, 312, 325.
cataphracta, v. Mart., 217, 227, 312, 325.
ciliaris, Müll. & Tr., 217, 220, 286, 312, 325.
cœrulea, Hutt., 218, 227, 312.
comata, Müll. & Tr., 218, 223, 228, 312.
cheneyi, Lym., 226.
clypeata, Ljn., 229.
demessa, Lym., 217, 226, 312.
dumosa, Lym., 216, 226, 312, 325.
echinata, Müll. & Tr., 214, 215, 224, 225, 312, 325.
„ Ltk., 225.
echinophora, Mull. & Tr., 224.
elegans, Ltk., 218, 227, 312, 326.
exigua, Lym., 217, 220, 300, 302, 312, 325.
fragilis, Dub. & Kor., 215, 224, 312, 314, 323.
„ Mull. & Tr., 214, 225.
„ (pars) Sars, 224.
„ (var. *tenuispina*), Sars, 225.
fumaria, Müll. & Tr., 215, 225, 312.
galateæ, Ltk., 217, 227, 312, 325.
hirsuta, Müll. & Tr., 214, 217, 218, 226, 312, 325.
koreana, Duncan, 216, 312.
kröyeri, Ltk., 219, 226.
lineata, Lym., 216, 226, 312, 325.
longipeda, Müll. & Tr., 214, 217, 220, 298, 299, 300, 301, 303, 312, 325 (Pl. XLVII. fig. 4).
„ (young), Ltk., 220.
lusitanica, Ljn., 215, 225, 312, 325.
lütkeni, Wyv. Thom., 215, 218, 286, 316.
maculata, Ljn., 215, 225, 314.
magnifica, Lym., 215, 216, 226, 312, 325.
martensi, Lym., 216, 221, 299, 312, 325.
melanosticta, Grube, 216, 222, 300, 312, 326
Ophiothrix nereidina, Müll. & Tr., 217, 221, 286, 312, 325.
örstedii, Ltk., 214, 216, 226, 312, 325.
pallida, Ljn., 218, 227, 316.
parasita, Müll. & Tr., 217, 226, 312.
pentaphyllum, Ljn., 214, 215, 225, 312, 323.
plana, Lym., 216, 228, 312, 326.
planulata, Stimp., 218, 227, 312, 325.
propinqua, Lym., 217, 220, 286, 298, 312, 325.
punctolimbata, v. Mart., 217, 227, 312, 325.
purpurea, v. Mart., 218, 223, 299, 301, 312, 326.
pusilla, Lym., 217, 220, 255, 302, 312, 325.
quinquemaculata, Müll. & Tr., 214, 215, 225, 312, 325 (Pl. XLII. figs. 5–8).
rammelsbergii, Müll. & Tr., 224.
roseo-cœrulans, Grube, 215, 225, 312, 325.
rotata, v. Mart., 217, 227, 312, 325.
rubra, Ljn., 224, 225.
rudis, Lym., 216, 226, 312, 325.
spiculata, Le Conte, 214, 216, 226, 312, 325.
spongicola, Stimp., 216, 227, 312.
stelligera, Lym., 217, 220, 286, 299, 303, 312, 325.
striolata, Grube, 216, 222, 302, 303, 312, 315, 326.
suensonii, Ltk., 215, 218, 222, 223, 229, 287, 312, 315, 326.
trilineata, Ltk., 214, 216, 222, 298, 312, 326.
triglochis, Müll. & Tr., 216, 218, 219, 291, 312.
triloba, v. Mart., 217, 227, 312, 325.
virgata, Lym., 217, 227, 286, 312, 326.
viridialba, v. Mart., 218, 228, 315, 326.
violacea, Müll. & Tr., 219.
Ophiothyreus, Ljn., 28.
goësi, Ljn., 28, 313, 315.
Ophiotrochus, Lym., 103.

Ophiotrochus panniculus, Lym., 103, 303, 318 (Pl. IX. figs. 12–14).
Ophiozona, Lym., 21, 25.
antillarum, Lym., 21, 23, 287, 315 (Pl. XI. figs. 7–9).
depressa, Lym., 21, 24, 303, 315, 322 (Pl. XI. figs. 16–18).
(?) *dubia*, Lym., 21, 25, 287, 317.
impressa, Lym., 21, 290, 310, 324. (Pl. XXXVII. figs. 13–15).
insularia, Lym., 21, 22, 298, 315 (Pl. XI. figs. 10–12).
nivea, Lym., 21, 22, 287, 313, 315, 324.
pacifica, Lym., 21, 25, 310, 324.
stellata, Lym., 21, 22, 297, 318, 321, 322 (Pl. XI. figs. 13–15).
tessellata, Lym., 21, 25, 315.
Ophiura, Lmk., 7, 11, 14, 18, 19.
abyssicola, Fbs., 83.
affinis, Ltk., 77.
albida, Fbs., 76.
ammothea, Leach, 112.
angulata, Say, 219.
annulosa, Blainv., 19.
,, Lmk., 175.
appressa, Say, 8, 9, 290, 309, 323.
arctica, Ltk., 76.
aurora, Risso, 76.
bellis, Flem., 112.
bracteata, Johnston, 76.
brevicauda, Lym., 8, 9, 309, 313, 323.
brevispina, Say, 8, 9, 290, 309, 313, 323.
carnea, Sars, 76.
ciliaris, Lmk., 220, 225.
cinerea, Lym., 8, 9, 287, 290, 309, 313, 323.
coriacea, Ltk., 40.
crassispina, Say, 171.
cuspidifera, Lmk., 249.
cylindrica, Hutt., 15.
daniana, Vll., 8, 10, 309, 323.
echinata, Lmk., 171.
elaps, Lym., 7, 8, 11, 313 (Pl. XXXVII. figs. 1–3; Pl. XLVI. fig. 3).
elegans, Leach, 136.
elongata, Say, 158.
Ophiura, *fasciculata*, Fbs., 77.
flaccida, Say, 246.
flemingii, Leach, 112.
filiformis, Lmk., 144.
grubei, Heller, 77.
guttata, Lym., 8, 9, 309, 323.
hispida, Ayres, 219.
holmesii, Lym., 8, 9, 309, 323.
incrassata, Lmk., 173.
isacantha, Say, 165.
januarii, Lym., 8, 10, 309, 323.
lacertosa, Lmk., 10.
lævis, Lym., 8, 10, 266, 309, 323.
longipeda, Lmk., 220.
nodosa, Ltk., 78.
normani, Hodge, 77.
maculata, Hutt., 15.
marmorata, Lmk., 229.
moniliformis, Grube, 136.
neglecta, Johnston, 136.
nereidina, Lmk., 221.
olivacea, Lym., 9.
panamensis, Lym., 8, 10, 309, 323.
paucispina, Say, 19.
pentagona, Lmk., 246.
picta, Kuhl & v. Hasselt, 174.
reticulata, Say, 162.
retzii, Nilsson, 186.
rosularia, Grube, 198.
rubicunda, Lym. 8, 10, 309, 323.
sarsii, Ltk., 40.
scolopendrina, Lmk., 170.
septemspinosa, Kuhl & v. Hasselt, 17.
sericea, Fbs., 79.
Ophiura squamata, Lmk., 172.
squamosa, Ltk., 77.
squamosissima, Lym., 8, 11, 309, 323.
stuwitzii, Ltk., 77.
tenorii, Heller, 77.
teres, Lym., 8, 11, 309, 323.
texturata, Lmk., 76.
tongana, Lym., 8, 9, 286, 309, 323.
variegata, Lym., 8, 10, 309, 323.
wahlbergii, Lym., 8, 10, 309, 323.
Ophiure, Savigny, 161.
écailleuse, Blainv., 220.

Ophiure lezardelle, Blainv., 10.

Pectinura, Fbs., 13, 14, 16, 19.
arenosa, Lym., 14, 15, 296, 313 (Pl. XXIII. figs. 10–12).
forbesii, Heller, 109.
gorgonia, Ltk., 14, 15, 298, 310, 323.
heros, Lym., 14, 16, 300, 309, 317, 322 (Pl. XXIII. figs. 7–9).
infernalis, Ltk., 14, 16, 17, 310, 323.
maculata, Vll., 14, 15, 297, 310, 323.
marmorata, Lym., 14, 17, 310, 323.
rigida, Lym., 14, 15, 286, 310, 323.
septemspinosa, Ltk., 14, 17, 310, 323.
spinosa, Lym., 14, 16, 17, 310, 323.
stellata, Ltk., 14, 15, 16, 302, 310, 323.
verrucosa, Studer, 14, 17, 313, 323.
vestita, Fbs., 14, 17, 313, 323.
Polypholis echinata, Duncan, 112.

See sonne, Pontoppidan, 264.

Sigsbeia, Lym., 249.
murrhina, Lym., 250, 315, 317, 326 (Pl. XLIII. figs. 4–6).
Stella arborescens, Rondelet, 263.
lævis, Rondelet, 10.
lumbricalis lacertosa, Linck, 76.
lumbricalis longicauda, Linck, 10.
marina-minor echinata purpurea, Sloane, 219.
pentagona scolopendroides regularis, Linck, 246.
scolopendroides; Jamaicensis purpurea, Linck, 219.

Trichaster, Agas., 256, 266.
elegans, Ludwig, 267, 313, 326.
flagellifer, v. Mart., 267.
isidis, Duchassaing, 270.
palmiferus, Agas., 267, 313, 326.

Zottenkopf, Knorr, 263.

POSTSCRIPT.

After the death of Sir Wyville Thomson, and when this work was already printed, some bottles containing Challenger Ophiuroidea were found in his study, among the collections he had retained for examination. Most of the species had been described. There was, however, one new *Ophiacantha*, one *Ophiomastus*, and a species of a new genus. These will be described and figured in the Bulletin of the Museum of Comparative Zoology.

The following is a list of the species above referred to :—

Ophioglypha irrorata (?), Lym. (adult). Off Coast of Portugal ; 470–1125 fathoms.
„ *lymani*. Station 313 ; 55 fathoms.
„ *deshayesi*, Lym. (young). Station 150 ; 150 fathoms.
„ *convexa*, Lym. Probably near Station 339.
„ *confragosa*, Lym. Off Coast of Portugal ; 470–1090 fathoms (?). Specimen with thick skin. It is found also off New England.
„ *bullata*, Wyv. Thom. Station 91 ; 2850 fathoms.
„ „ „ „ Some with large rosette of primary plates.
„ *kinbergii*. Port Jackson.
„ *minuta* (?), Lym. Station 285 ; 2375 fathoms. Differs from type in more numerous and swollen small disk scales, and in wanting the single tentacle scale.
„ *lepida* (var. ?), Lym. Station 1 ; 1127 fathoms. Numerous disk spines rarely seen in *Ophioglypha lepida*. Arm comb papillæ longer.

Ophiomusium planum, Lym. Differs from the typical original from West Indies only in less marked microscopic tuberculation. Off Coast of Portugal ; 470–1090 fathoms (?).
„ *lymani*, Wyv. Thom. Off Coast of Portugal.
„ „ „ Station 235.

Ophiactis carnea, Ljn. Simon's Bay, Cape of Good Hope ; 10–20 fathoms.
Ophiura brevispina, Lym. Off Bahia.

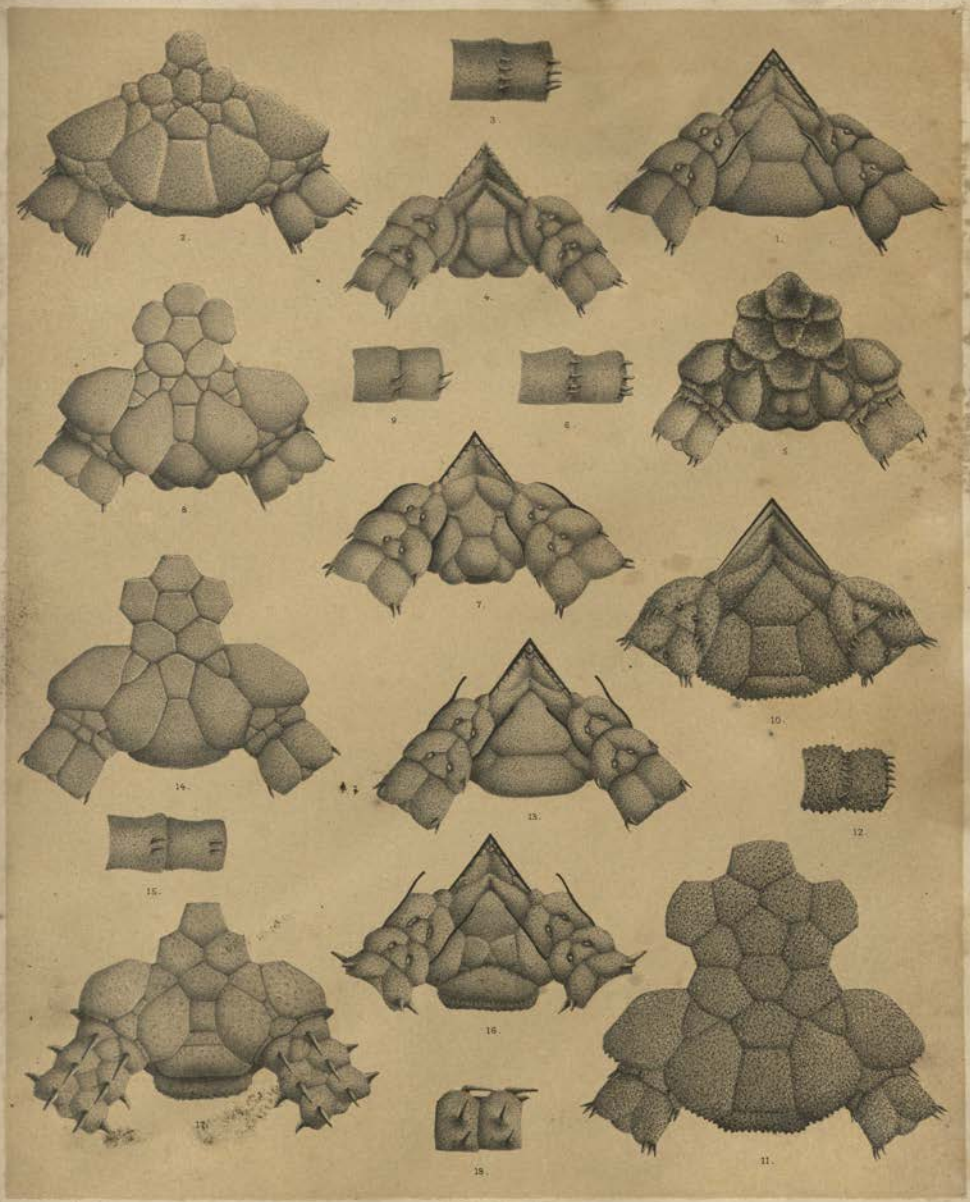
Ophiacantha, sp. nov. Station 235.
,, *vivipara*, Ljn. Station 320 ; 600 fathoms.
,, ,, Station 314 ; 20 fathoms.
,, ,, Station 313 ; 55 fathoms.
,, *abnormis*, Lym. Station 207 ; 700 fathoms.
Amphiura impressa (?), Lym. N. E. New Guinea ; 8 fathoms.
,, *verticillata* (?), Ljn. The ovaries are not external, but interbrachial skin has broken, letting out the egg clusters.
,, *studeri*, Lym. January 27, 1874. 95 fathoms.
,, *incana*, Lym. Simon's Bay, Cape of Good Hope ; 10–20 fathoms.
Ophionereis schayeri (?), Ltk. N. E. New Guinea. Kobi, March 17, 1875. 8 fathoms.
Ophiomitra chelys, Lym. Station 3 ; 1530 fathoms.
Ophiomaza cacaotica, Lym. Cape York.
,, ,, Station 187.
Ophiomastus, sp. nov. Station 173.
Ophiothamnus remotus, Lym. Station 142 ; 150 fathoms.
Ophiostigma africanum, Lym. St. Vincent, Cape Verde.
Ophiopyren brevispinus, Lym. Station 173 ; 310 fathoms.
Ophiothrix cæspitosa, Lym. Port Jackson ; 7 fathoms.
,, *angulata*, Ayres. Off Bahia ; shallow water.
,, *ciliaris* (?), Kobi. N. E. New Guinea. March 17–19, 1875. 8 fathoms.
Astronyx loveni, Müll and Tr. Station 232.
Astrotoma agassizii, Lym. Station 150 ; 150 fathoms.
Gen. nov. Station 219 ; 150 fathoms.

T. L.

CAMBRIDGE, U.S.A., *June* 15, 1882.

TABLE OF CONTENTS.

	PAGE
Introduction,	1
Description of Species,	6
Table of Doubtful Species,	286
List of Ophiuridæ and Astrophytidæ of the Challenger Expedition, arranged by Stations,	287
Bathymetrical Tables,	308
Temperature Tables,	320
Note on Fossil Species,	326
Abbreviations,	328
Explanation of the Plates,	332
Index,	368
Postscript,	385



L. Tempelet sc. et imp.

Each Person all nat.

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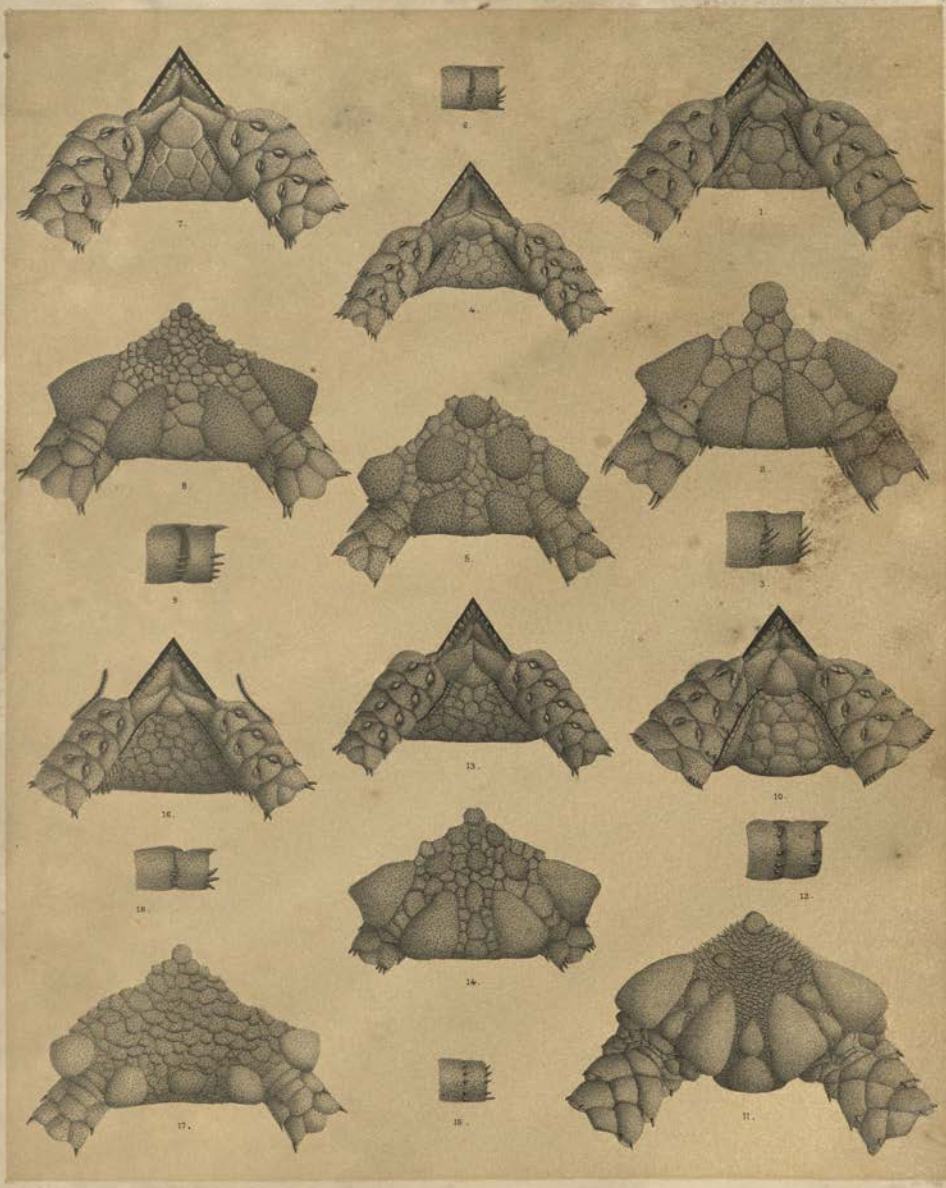
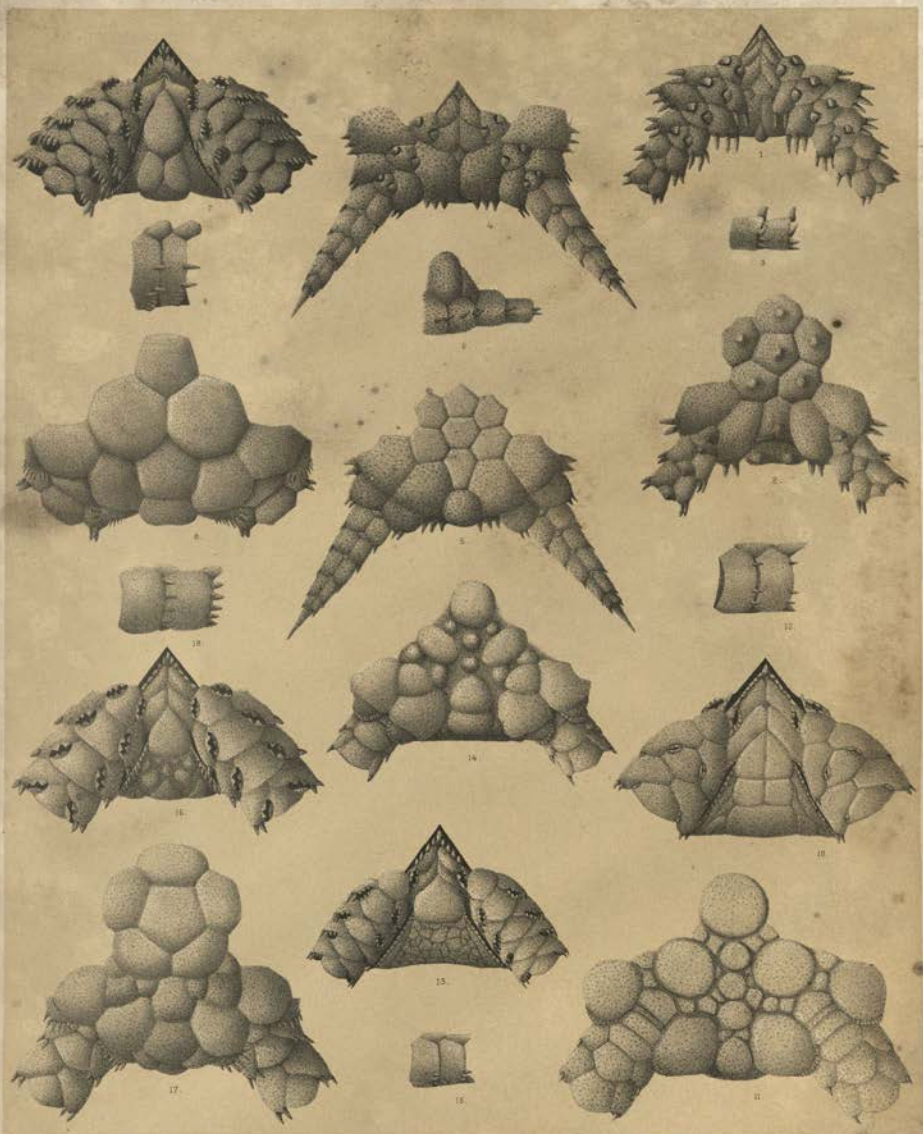
1-3 OPHIOMUSIUM VALIDUM, Lyn. 4-6. O. SCALARE, Lym. 7-9. O. SIMPLEX, Lym. 10-12. O. GRANOSUM, Lym.

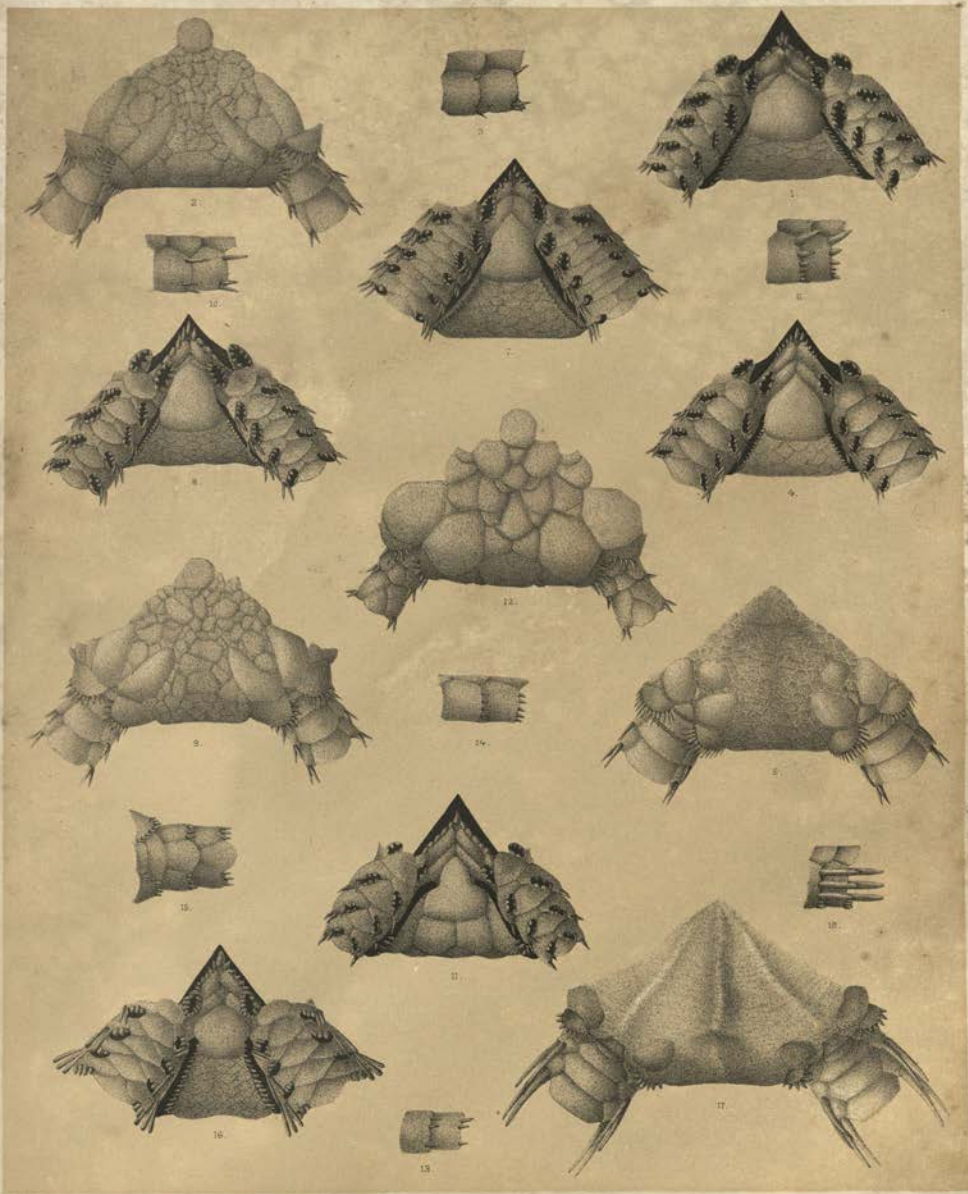
13-15. O. LUNARE, Lym. 16-18. O. LÜTKENI, Lym.



1-3. OPHIOMUSIUM SERRATUM, Lym. 4-6. O. ARCHASTER, Wyv. Thom. 7-9. O. ARMIGERUM, Lym. 10-12. O. LAQUEATUM, Lym.
13-15. O. CORTICOSUM, Lym. 16-18. O. CANCELLATUM, Lym.



1-3. OPHIOMUSIUM FULCHELLUM Wyv. Thom. 4-6. O. FLABELLUM. Lym.
7-9. OPHIOGLYPHA SOLIDA. Lym. 10-12. O. INORNATA. Lym. 13-15. O. RUGOSA. Lym. 16-18. O. UNDATA. Lym.



L. Trouvelot ad nat.

Kath. Peirson ad nat.

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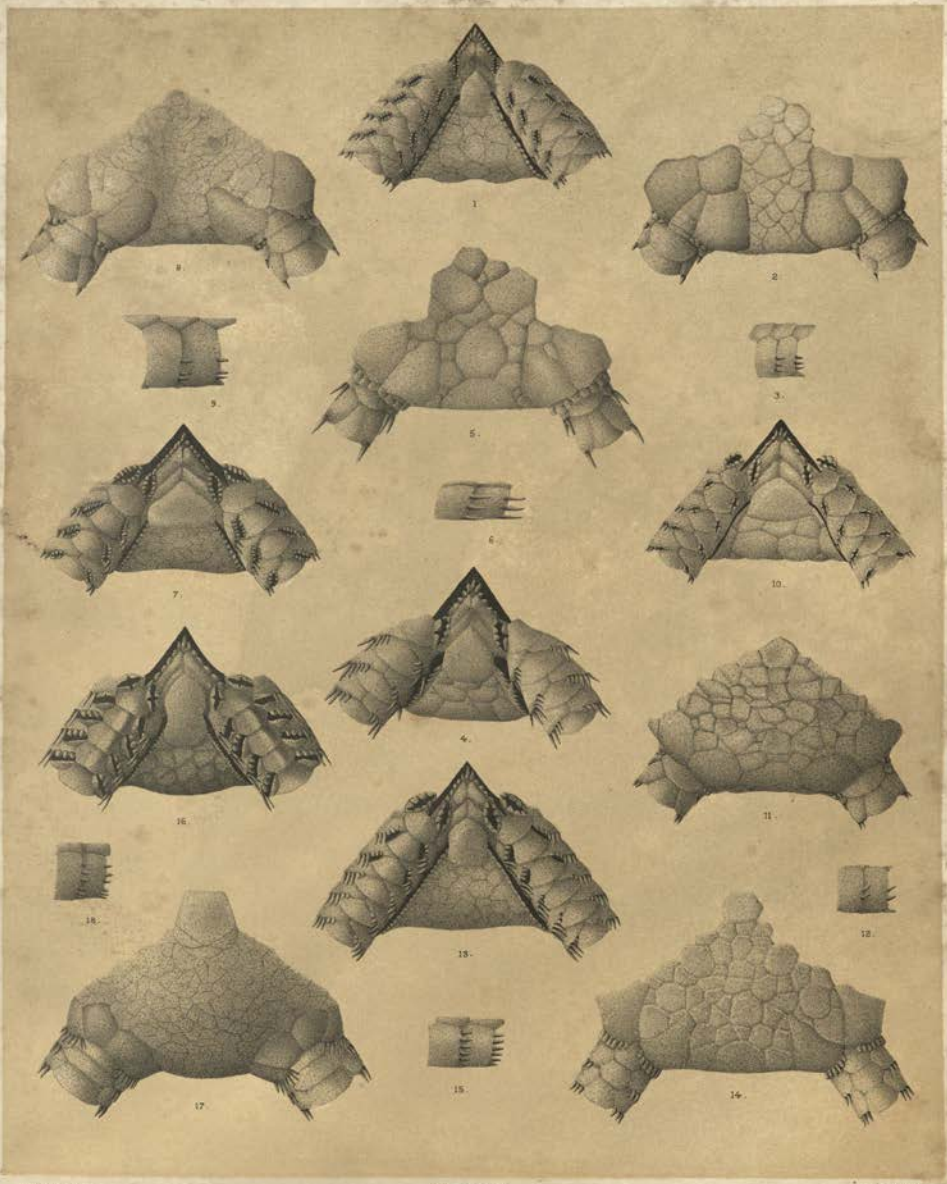
1-3. OPHIOGLYPHA LEPIDA. Lym. 4-6. O. PALLIATA. Lym. 7. O. FERRUGINEA. Lym. 8-10. O. LJUNGMANI. Lym.

11-13. O. IMBECILLIS. Lym. 14-15. O. ÆQUALIS. Lym. 16-18. O. FLAGELLATA. Lym.



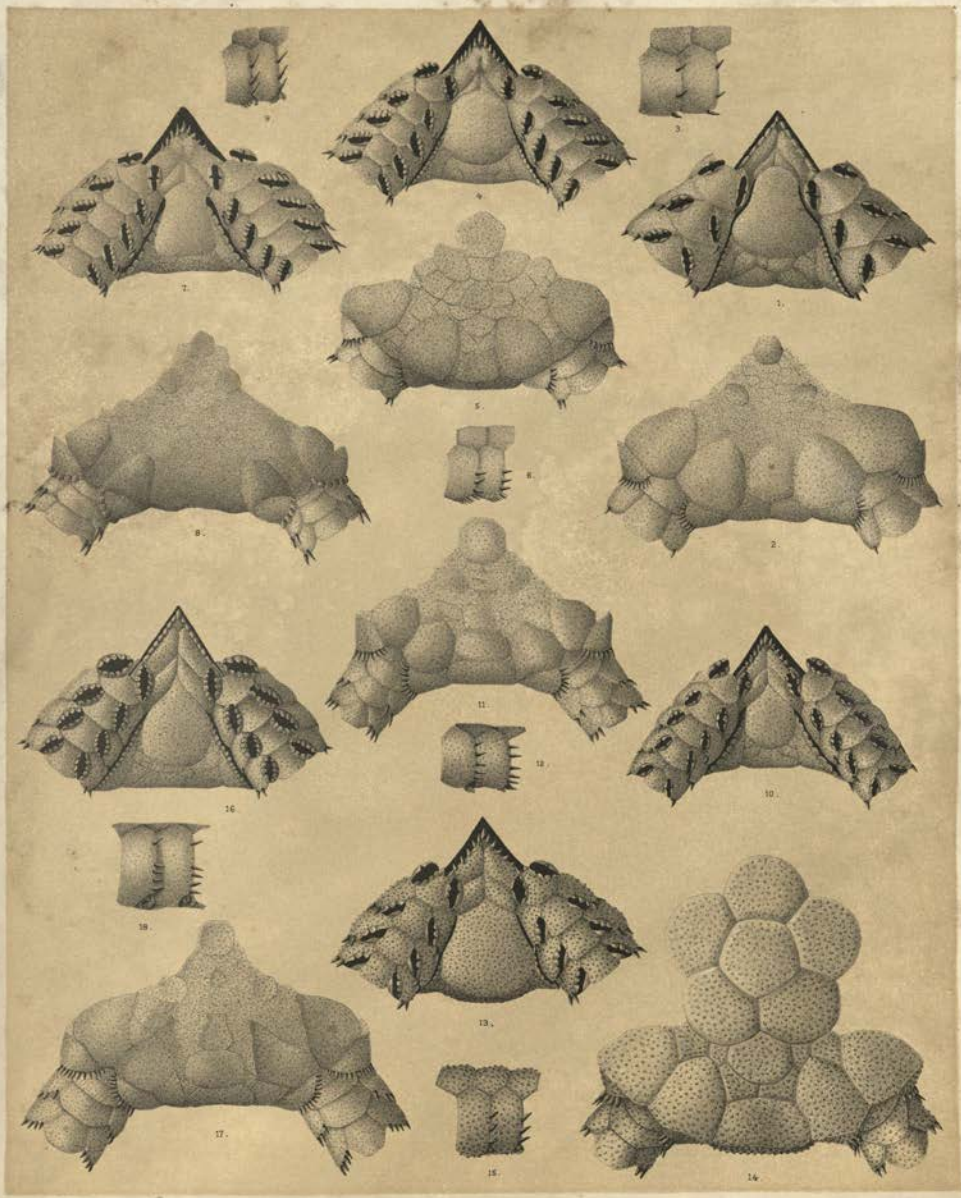
L. Trouvelot del. et sculp.

Kath. Peirson ad nat.

Printed by A. Maurel

1-3. OPHIOGLYPHA COSTATA, Lym. 4-6. O. JEJUNA, Lym. 7-9. O. IRRORATA, Lym. 10-12. O. UNDULATA, Lym.

13-15. O. ALBATA, Lym. 16-18. O. ELEVATA, Lym.



J. Trouvelot ad nat.

Kath. Poirson ad nat.

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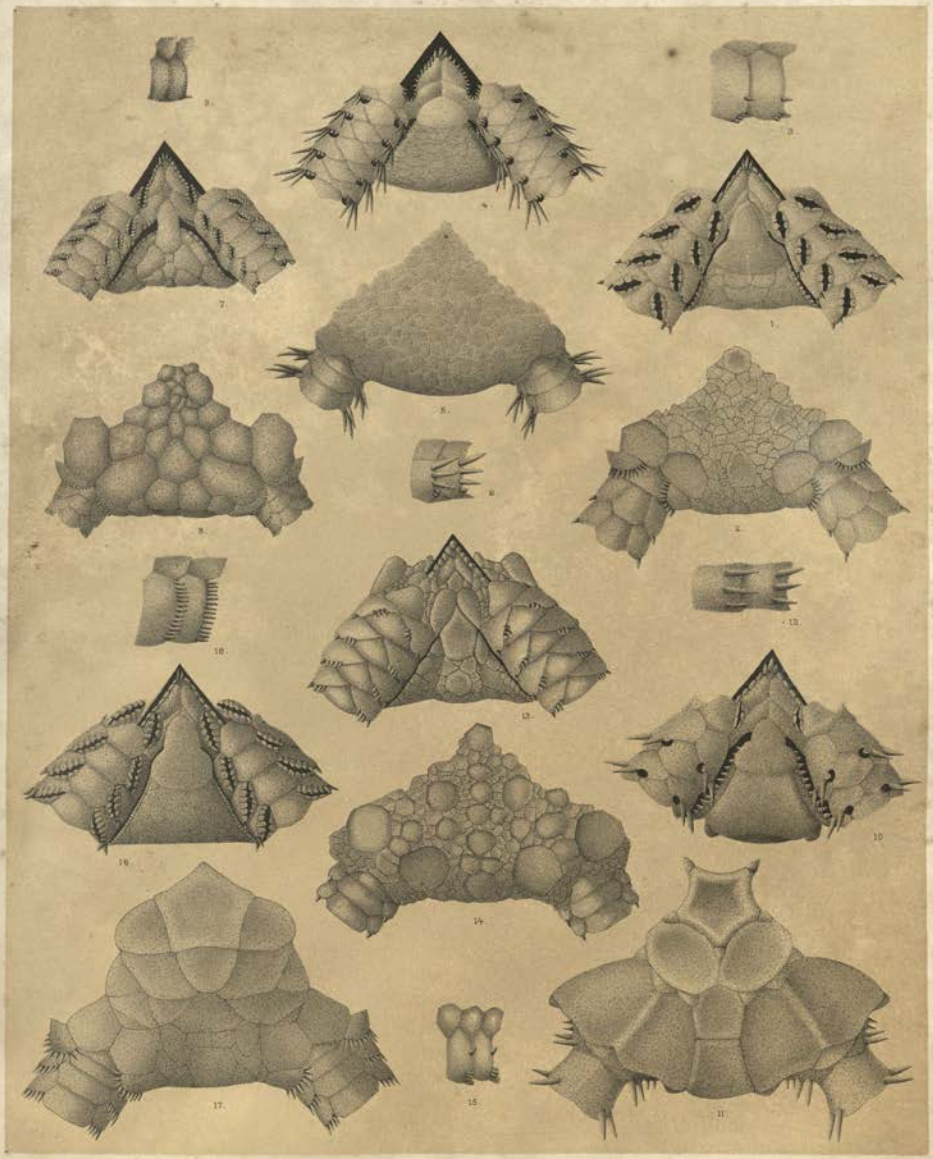
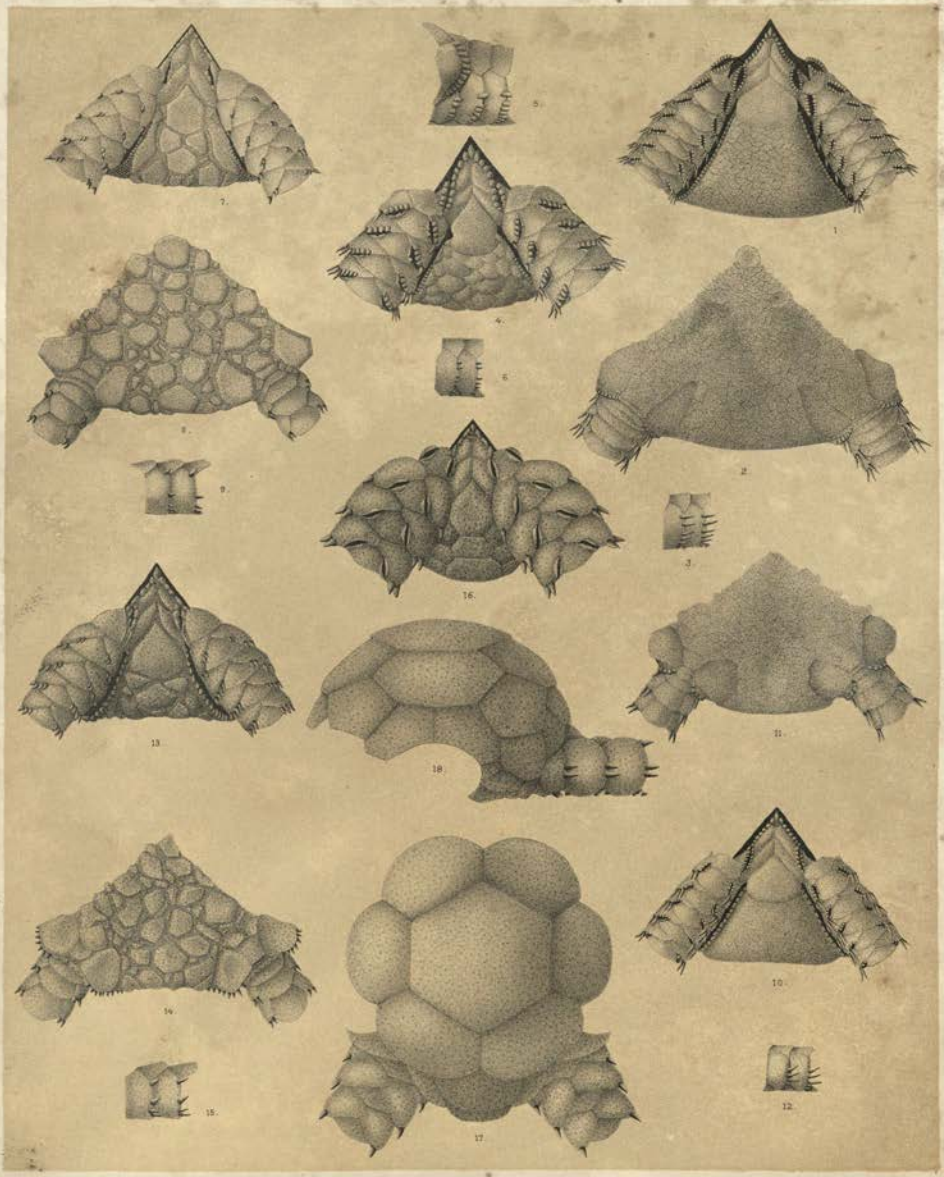
1-3. OPHIOGLYPHA ORNATA, Lym. 4-6. O. LACAZEI, Lym. 7-9. O. LIENOSA, Lym. 10-12. O. VARIABILIS, Lym.

13-15. O. CONVEXA, Lym. 16-18. O. SCULPTILIS, Lym.



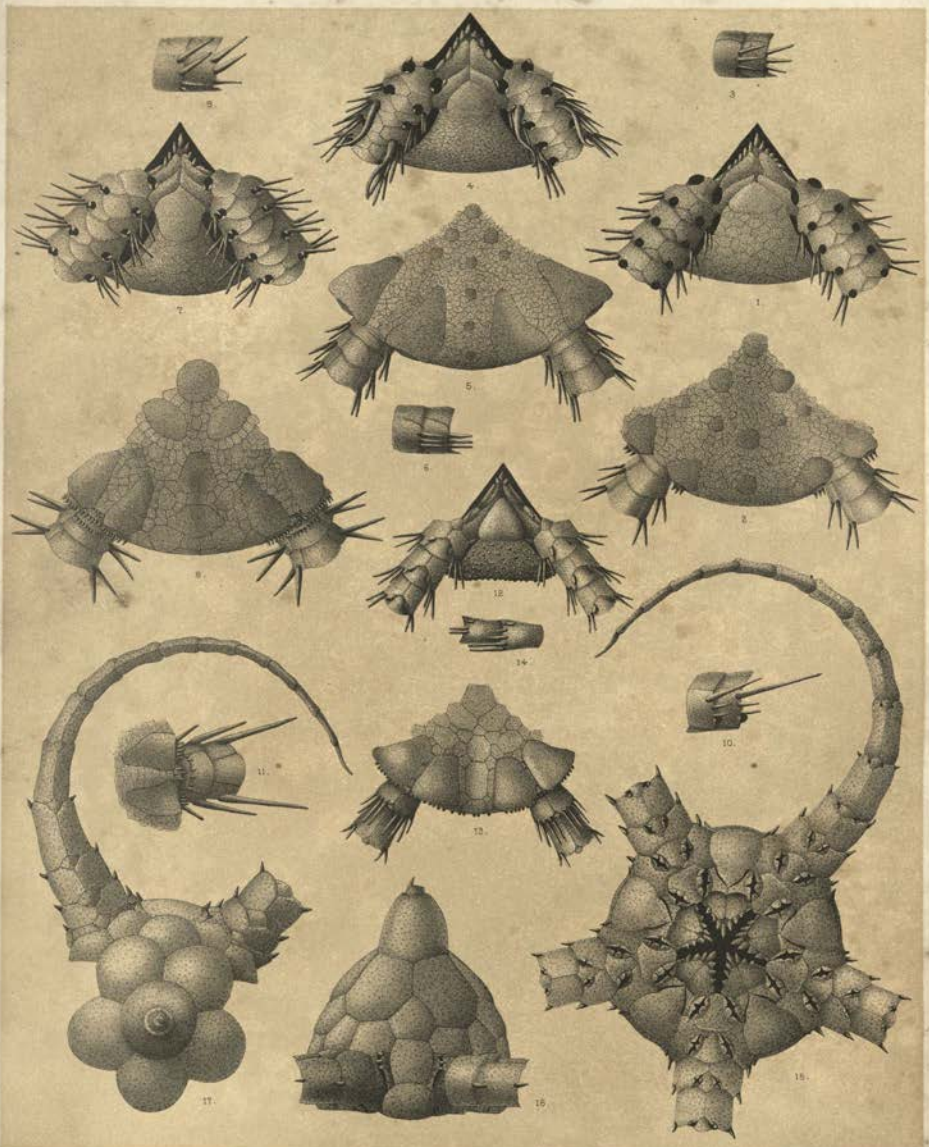
1-3. OPHIOGLYPHA RADIATA, Lym. 4-6. O. INERMIS, Lym. 7-9 O. PONDEROSA, Lym. 10-12. O. MINUTA, Lym.

13-15. O. DESHAYESI, Lym. 16-18 O. LAPIDARIA, Lym.



1-3. OPHIOGLYPHA LOVENI, Lym. 4-5. O. AMBIGUA, Lym. 6. O. FRATERNA, Lym. 7-9. O. CONFRAGOSA, Lym.

10-12. O. ORNICULATA, Lym. 13-15. O. INTORTA, Lym. 16-18. OPHIOMASTUS TERRIFICUS, Lym.



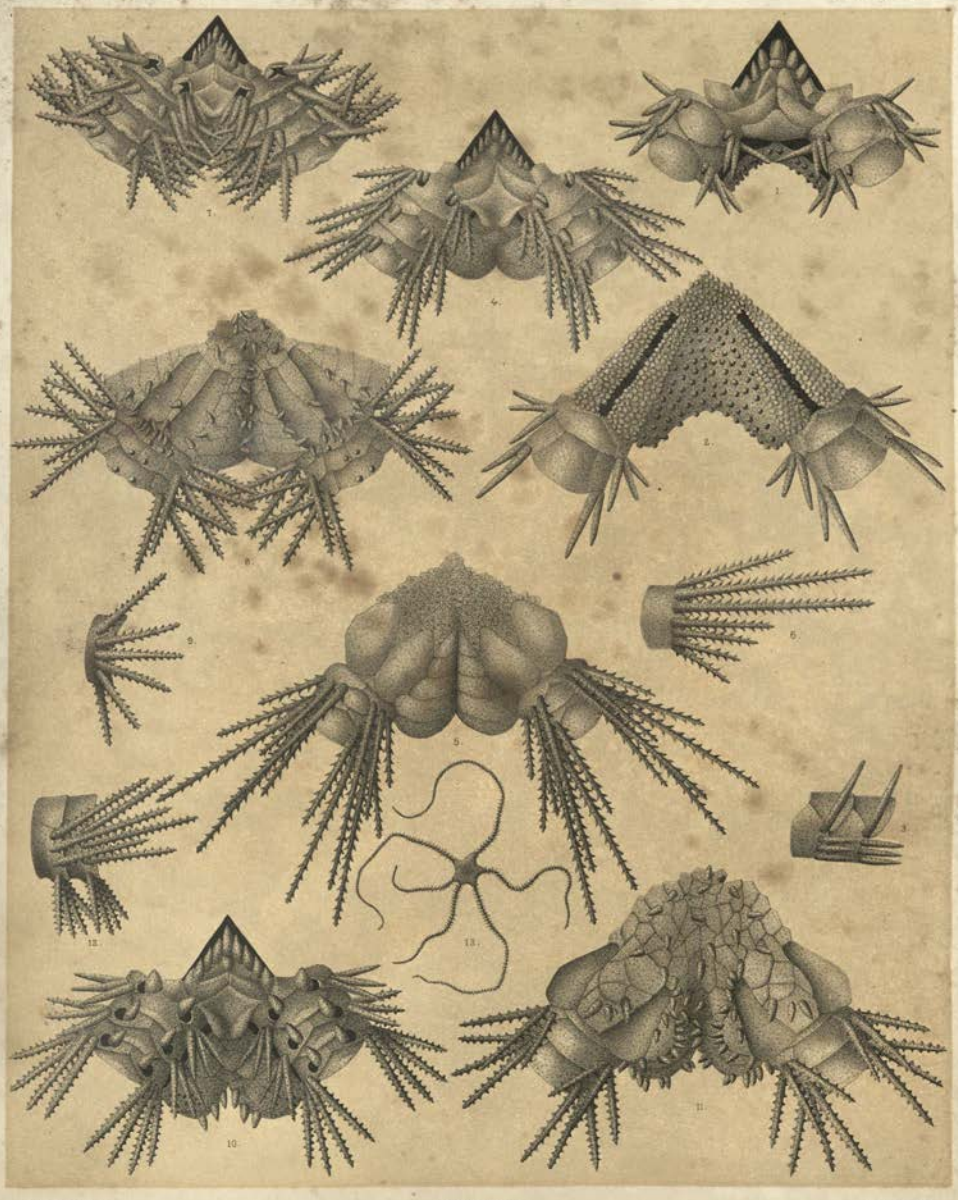
L. Bonnefoy del. et sculp.

Keith Petrow ad nat.

Printed by A. Mainet

1-3 Ophiocten umbraticum, Lym. 4-6 O. pallidum, Lym. 7-9 O. amitinum, Lym. 10-11 O. hastatum, Lym.

12-14 Ophiotrochus panniculus, Lym. 15-17 Ophiopyrous Wyville-Thomsoni, Lym.



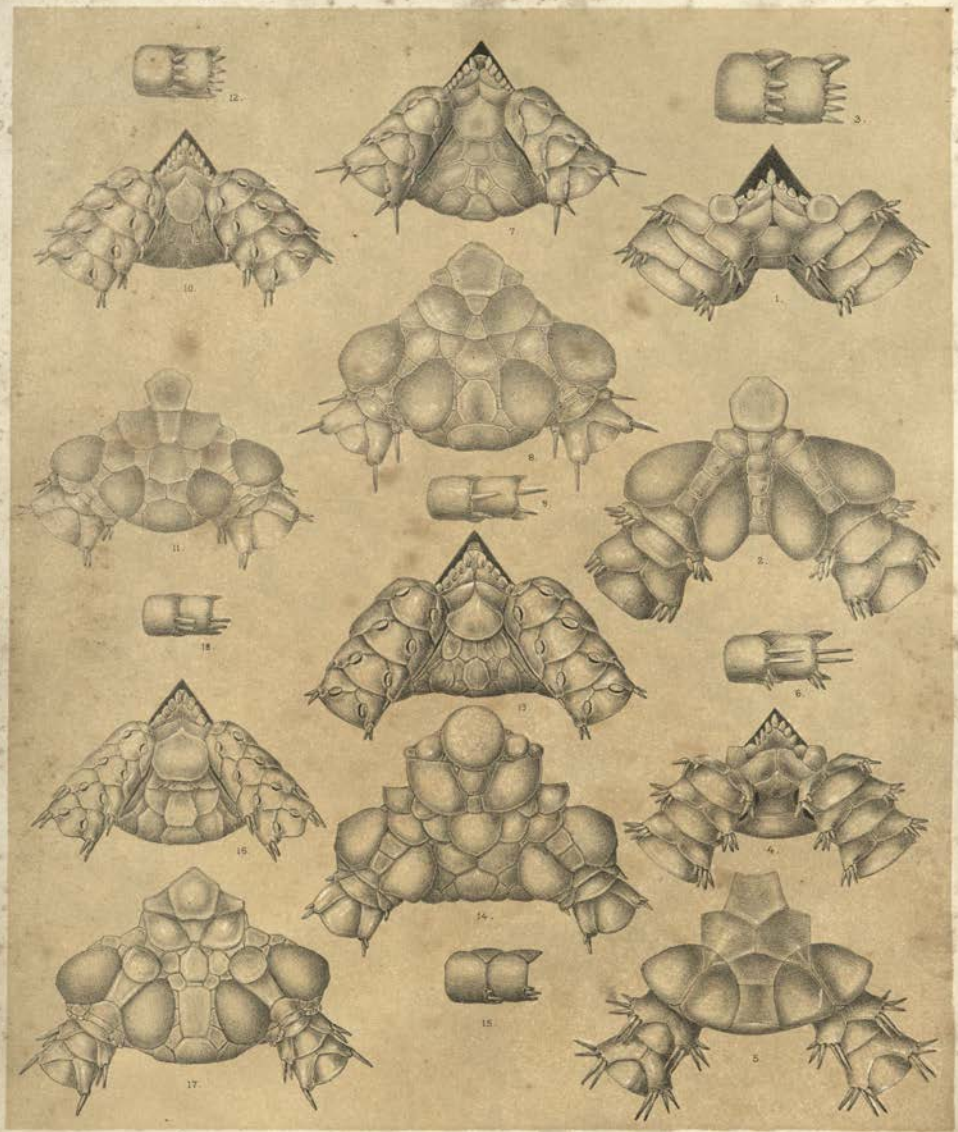
L. Tinnevelt del. et sculp.

Kach Petersen ad nat.

Printed by A. Mansel

1-3 Ophiocantha tuberculosa. Lym. 4-6 Ophiomitra dipsacus. Lym. 7-9 O. plicata. Lym. 10-12 O. sarsii. Lym.

13 Ophiosciasma attenuatum. Lym.



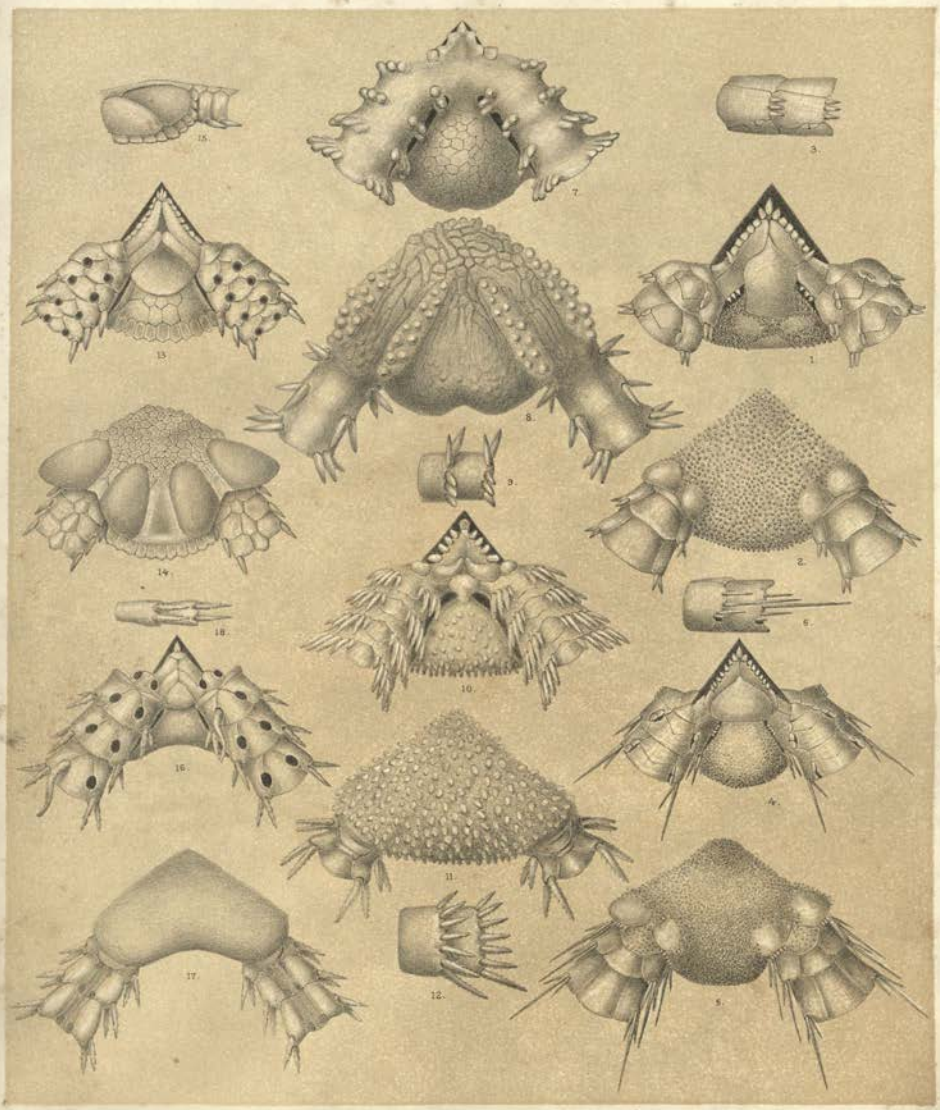
F. Kastner sc. Stone

Kath. Peirson ad nat.

Printed by A. Mansel

1-3 OPHIOCERAMIS OBSTRICTA, Lym. 4-6 O. CLAUSA, Lym.

7-9 OPHIOZONA ANTILLARUM, Lym. 10-12 O. INSULARIA, Lym. 13-15 O. STELLATA, Lym. 16-18 O. DEPRESSA, Lym.



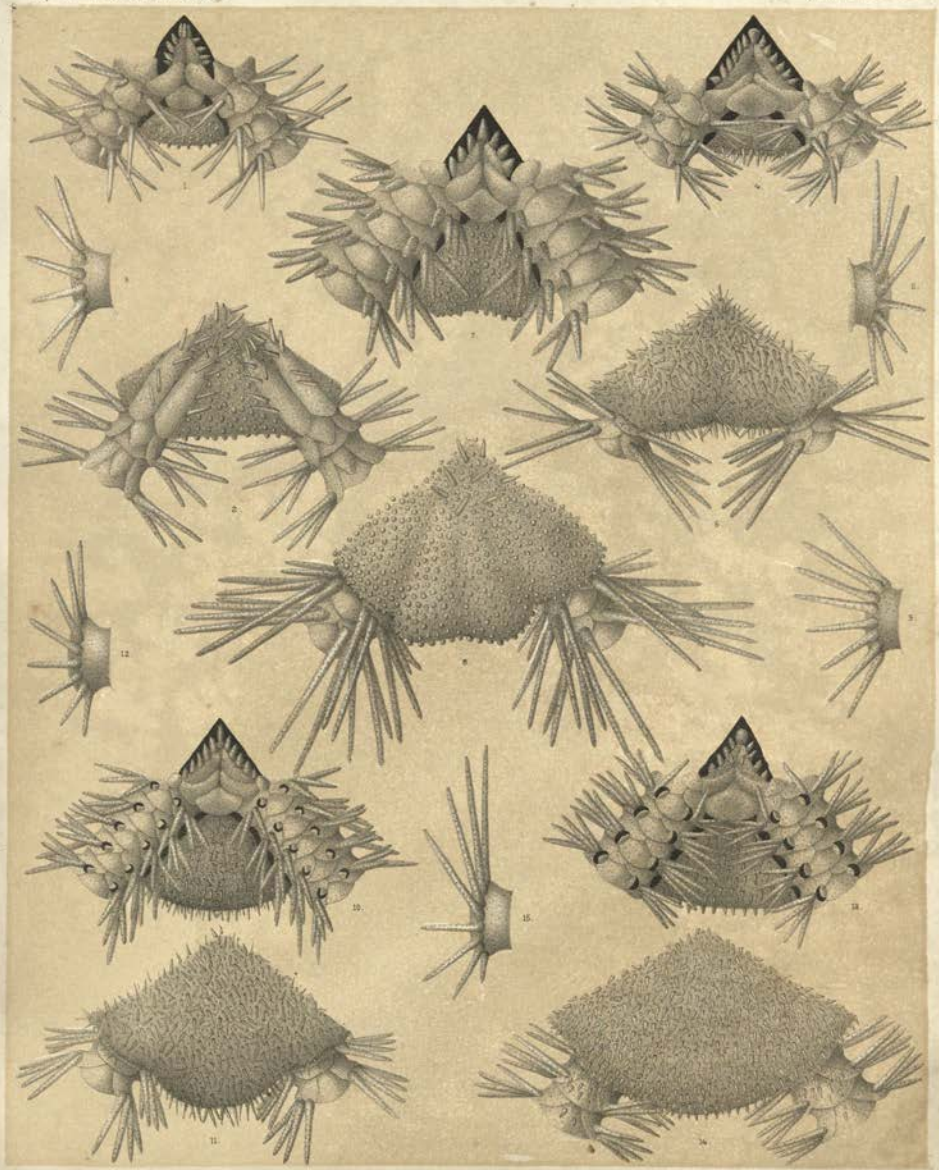
P. Kessler sc. alone

Kath. Peirson ad nat.

Printed by A. Meisel

1-3 Ophiopyren brevispinus, Lym. 4-6 O. longispinus, Lym. 7-9 Ophiolepis scorteus, Lym. 10-12 O. vestitus, Lym.

13-15 Ophiophyllum petilum, Lym. 16-18 Ophioceron edentulus, Lym.



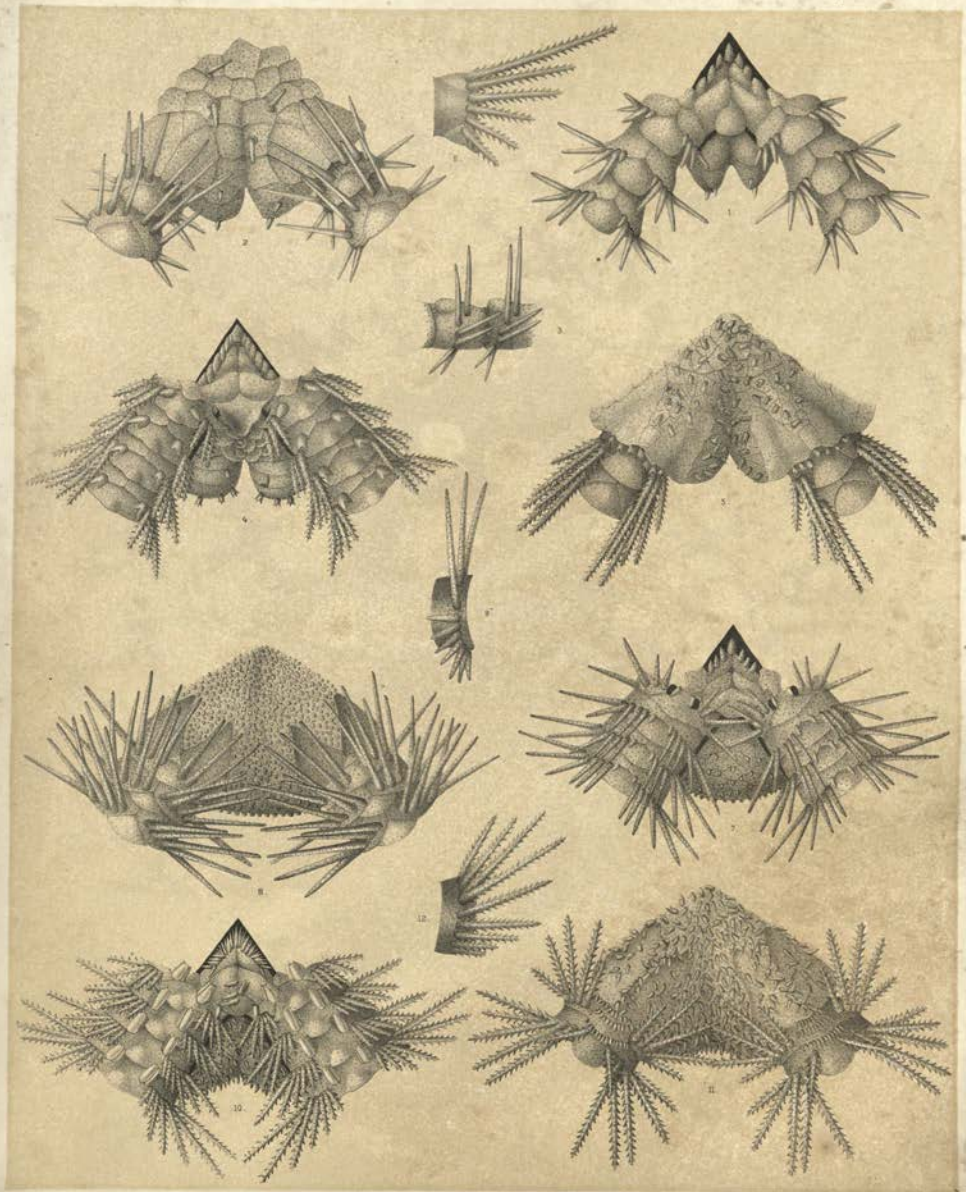
I. Tennentot ad nat.

Kath. Feirsen ad nat.

Printed by A. Mosel

1-3 OPHIACANTHA TROSCHELI, Lym. 4-6 O. STIMULEA, Lym. 7-9 O. VEPRATICA, Lym.

10-12 O. SENTOSA, Lym. 13-15 O. COSMICA, Lym.



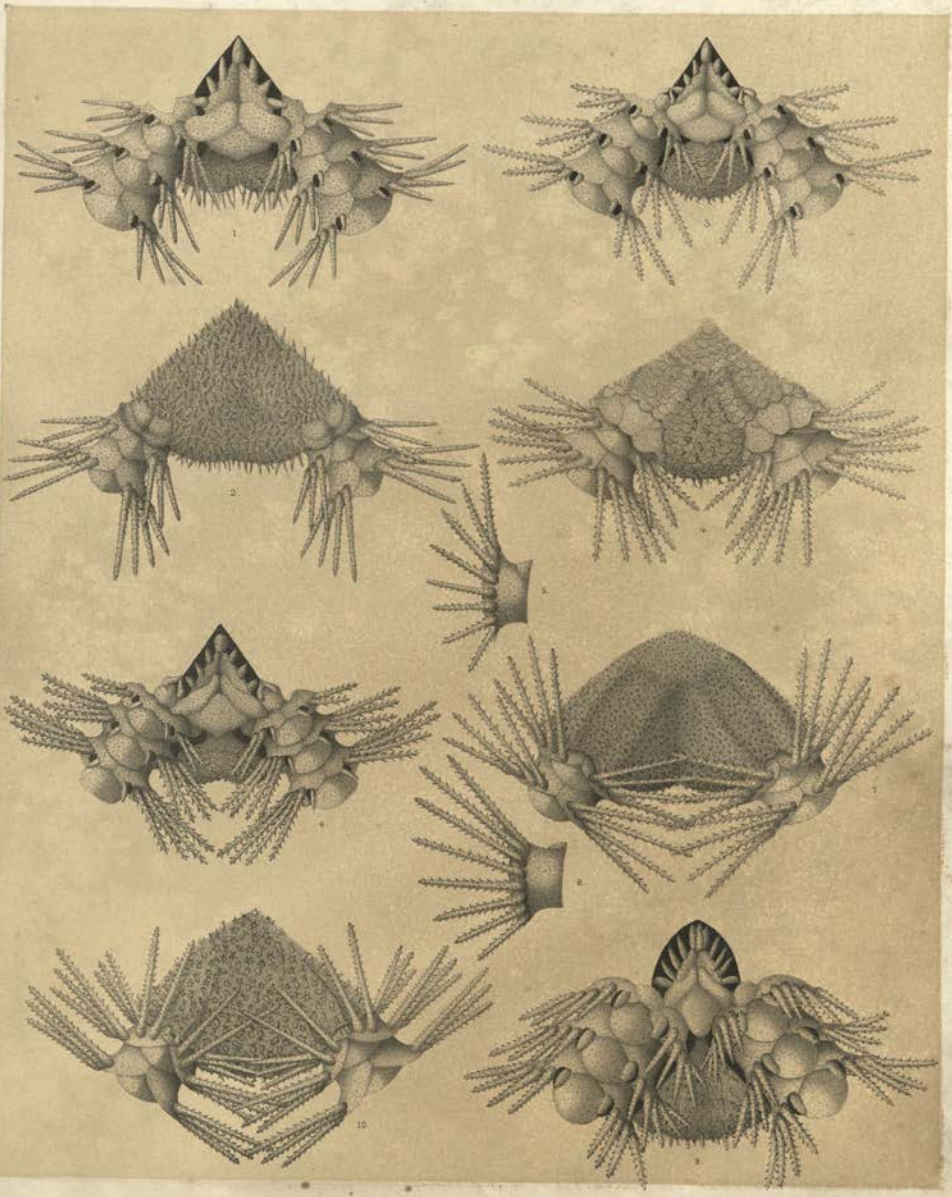
L. Trouvelot ad nat.

Kath. Petrowa ad nat.

Printed by A. Meisel.

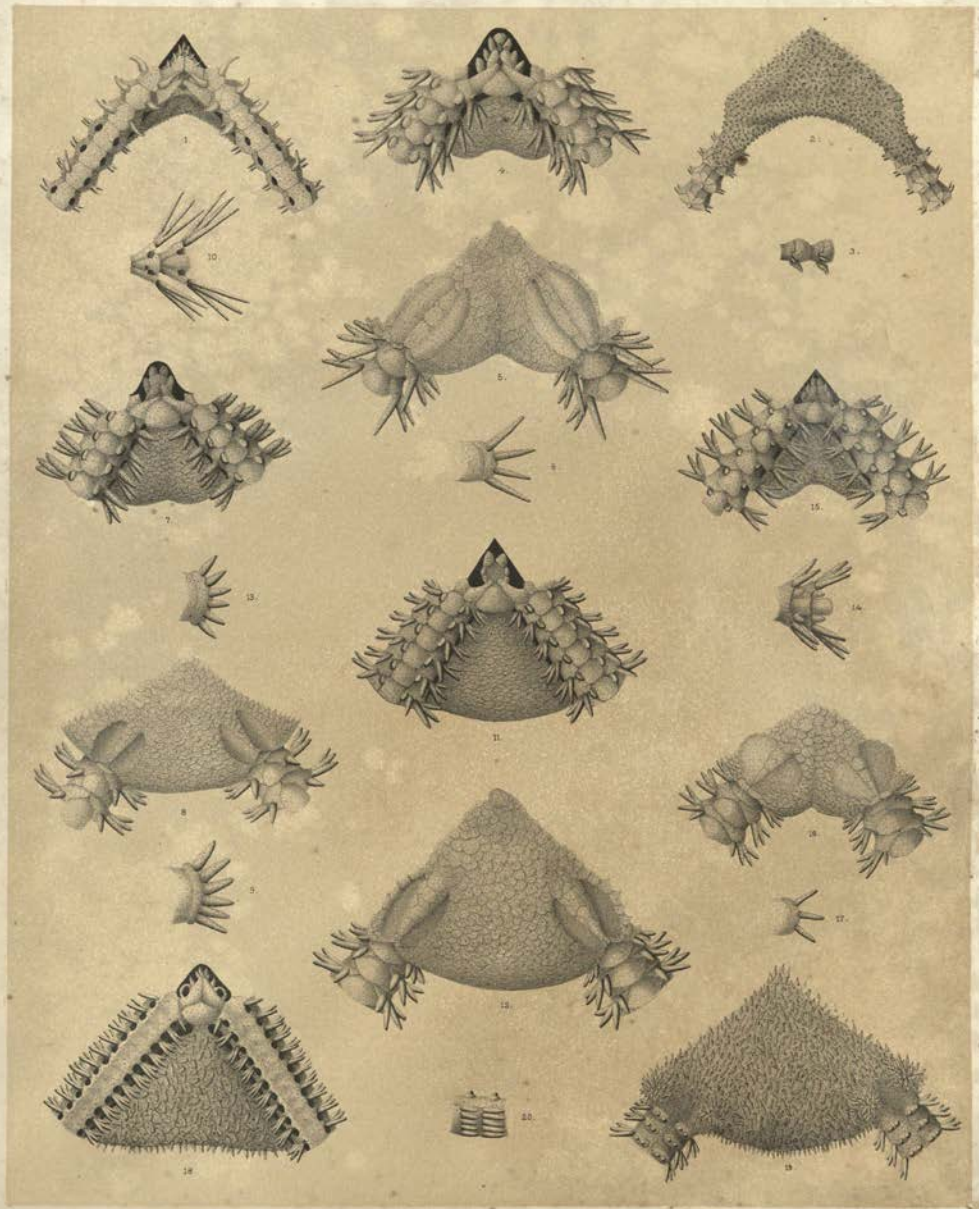
1-3 OPHIOTHAMNUS REMOTUS, Lym. 4-6 OPHIOMITRA CARDUUS, Lym.

7-9 OPHIACANTHA GRANULOSA, Lym. 10-12 OPHIOGAMAX VITREA, Lym.



1-2 OPHIACANTHA SEGESTA. Lym. 3-5 O. CORNUTA. Lym.

6-8 O. SERRATA. Lym. 9-10 O. CUSPIDATA. Lym.



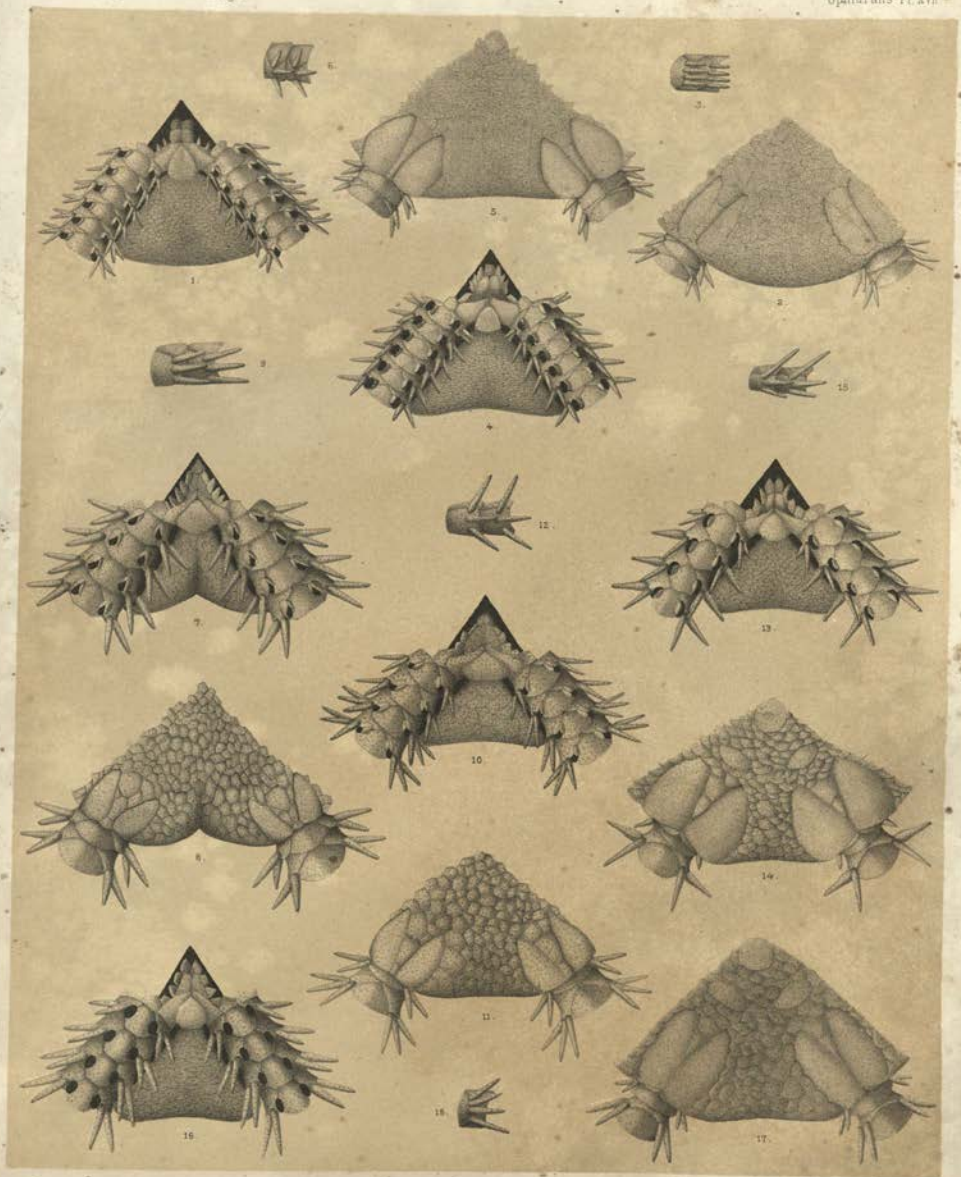
L. Dreuvelot del. et sculp.

Keith Fettman ad nat.

Printed by A. Mintzel

1-3 OPHIOSCIASMA ATTENUATUM, Lym. 4-6 AMPHIURA IRIS, Lym. 7-10 A. ARGENTEA, Lym. 11-14 A. CONSTRICTA, Lym.

15-17 A. ACACIA, Lym. 18-20 OPHIOKYRSA RUDIS, Lym.



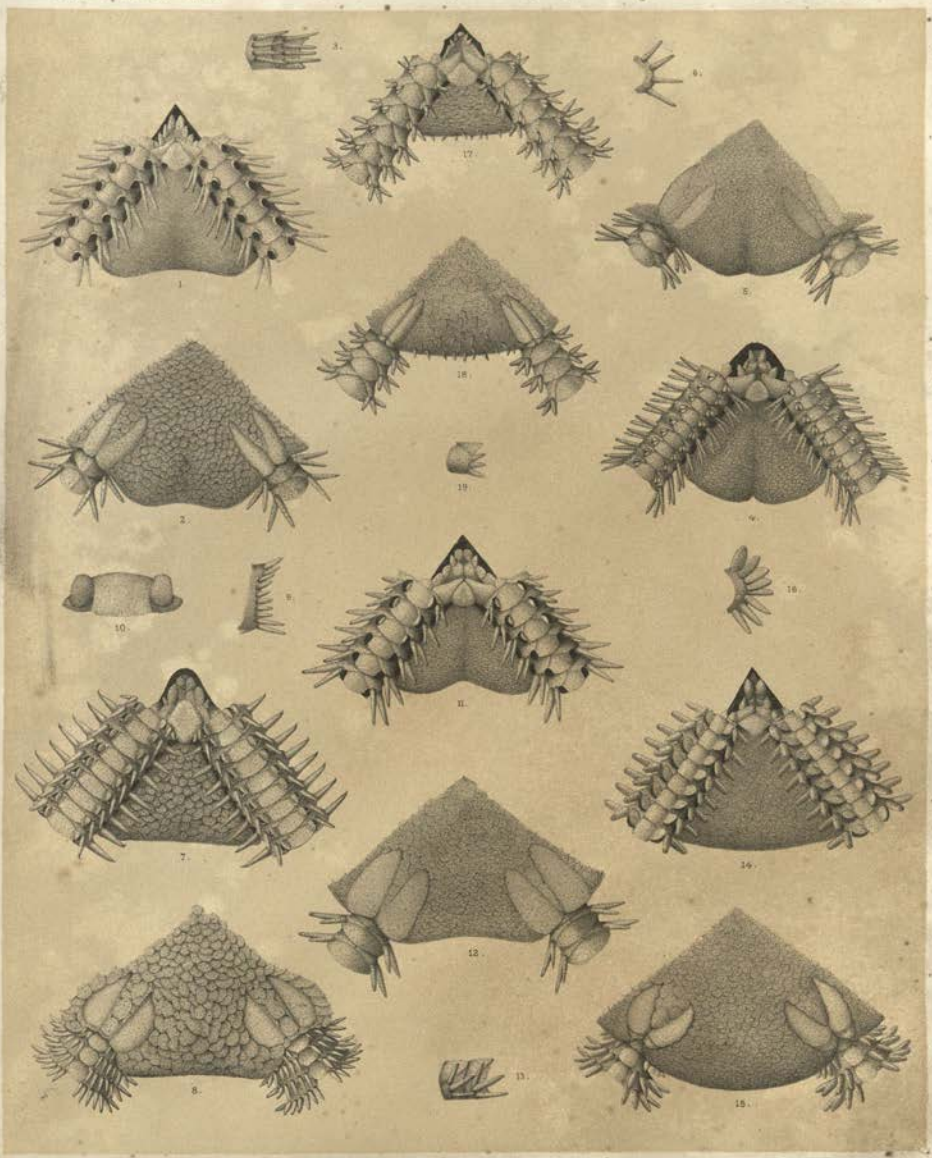
L. Troutbeck ad nat.

Kack, Petrowa ad nat.

Printed by A. Hoen

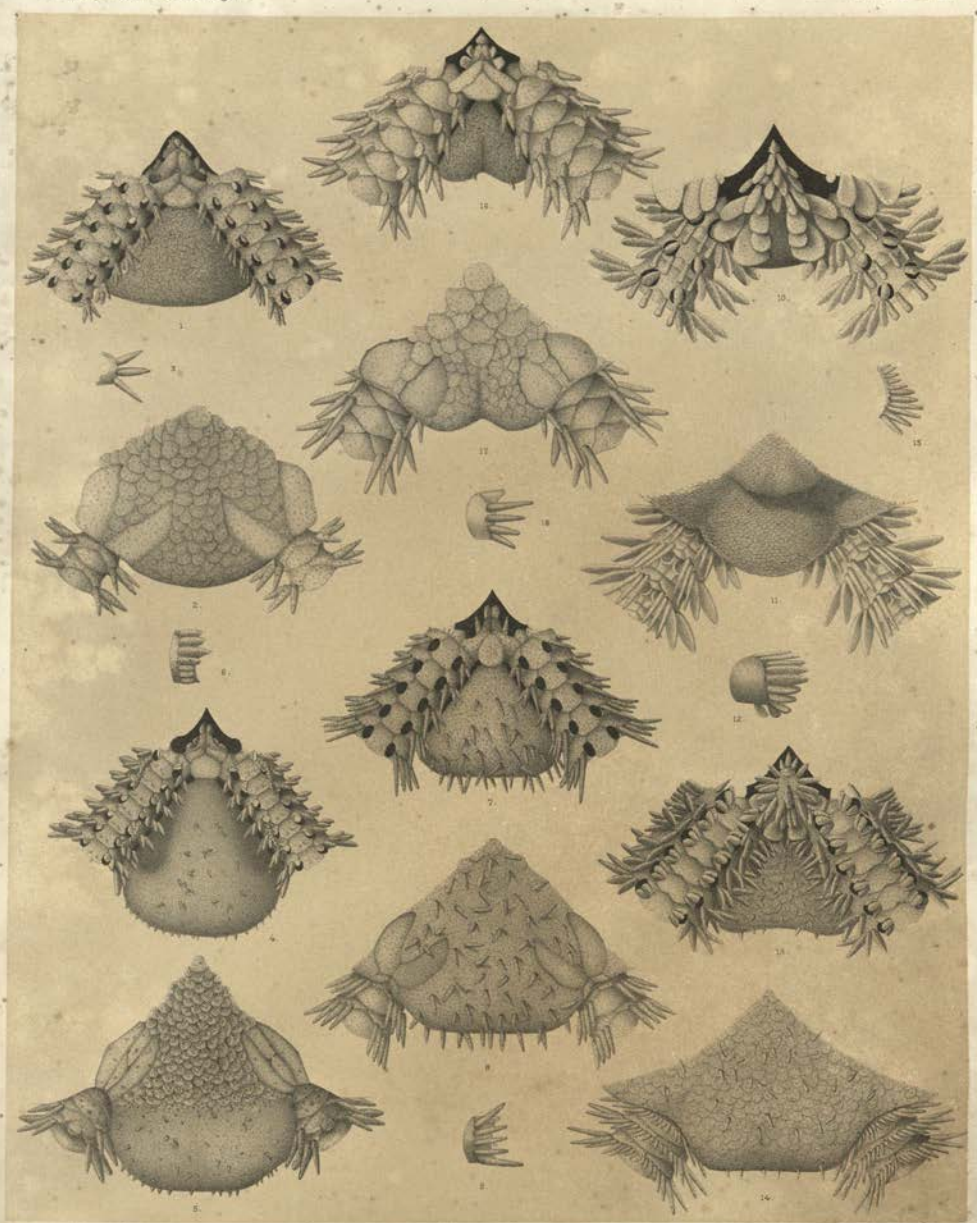
1-3 AMPHIURA CONCOLOR, Lym. 4-6 A. PATULA, Lym. 7-9 A. CANESCENS, Lym. 10-12 A. DUPLICATA, Lym. (var.)

13-15 A. CERNUA, Lym. 16-18 A. VERRILLI, Lym.



1-3 AMPHIURA GLAUCA. Lym. 4-6 A.BELLIS. Lym. 7-10 A.MAXIMA. Lym. 11-13 A.DALEA. Lym.

14-16 A.CAPENSIS. Lym. 17-19 OPHIOSTIGMA AFRICANUM. Lym.



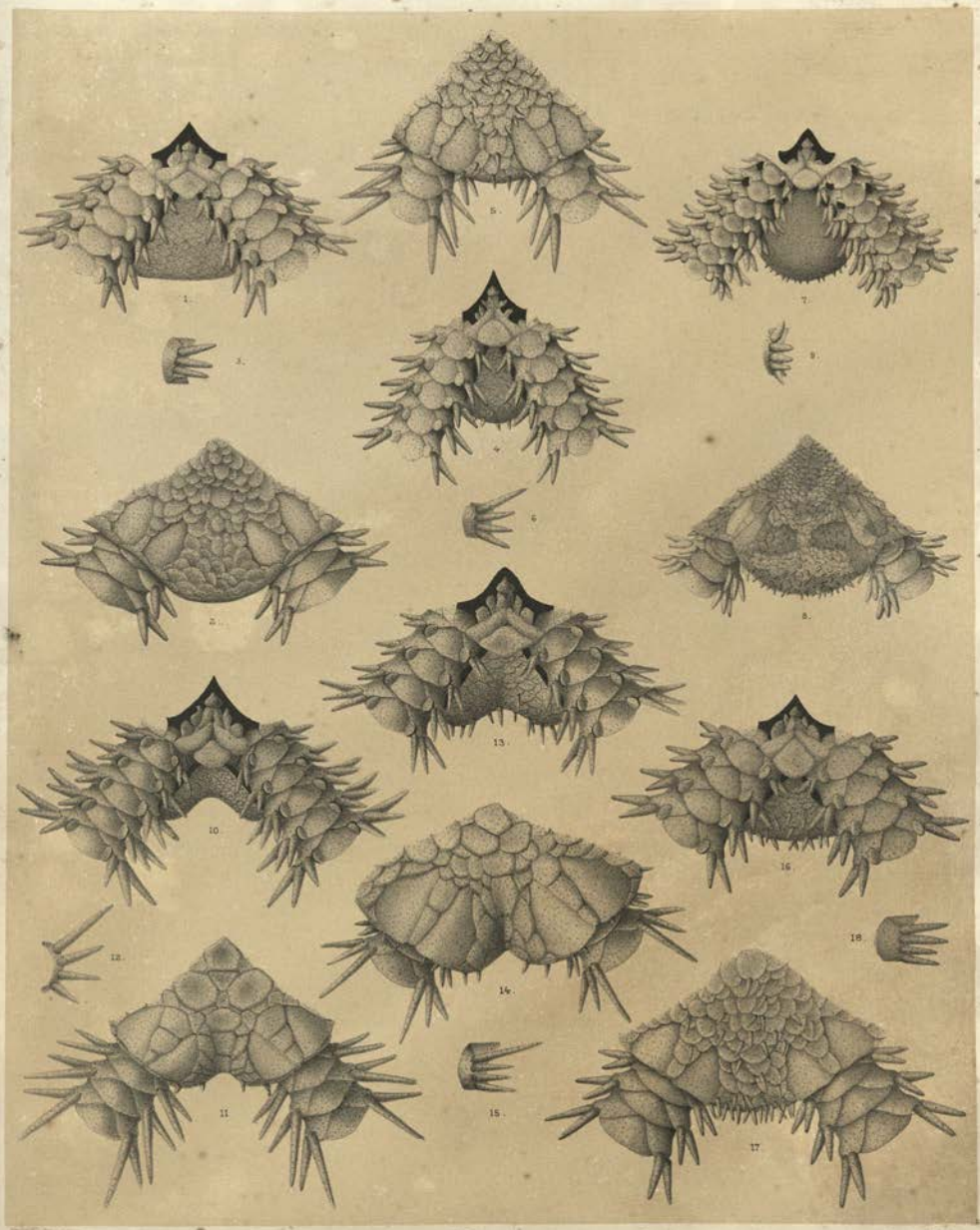
A. Tremolini del. et sculp.

Keith Pearson ad nat.

Printed by A. Mayer

1-3 AMPHILEPIS PATENS. Lym. 4-6 OPHIOCNIDA SCABRA. Lym. 7-9 O. PILOSA. Lym.

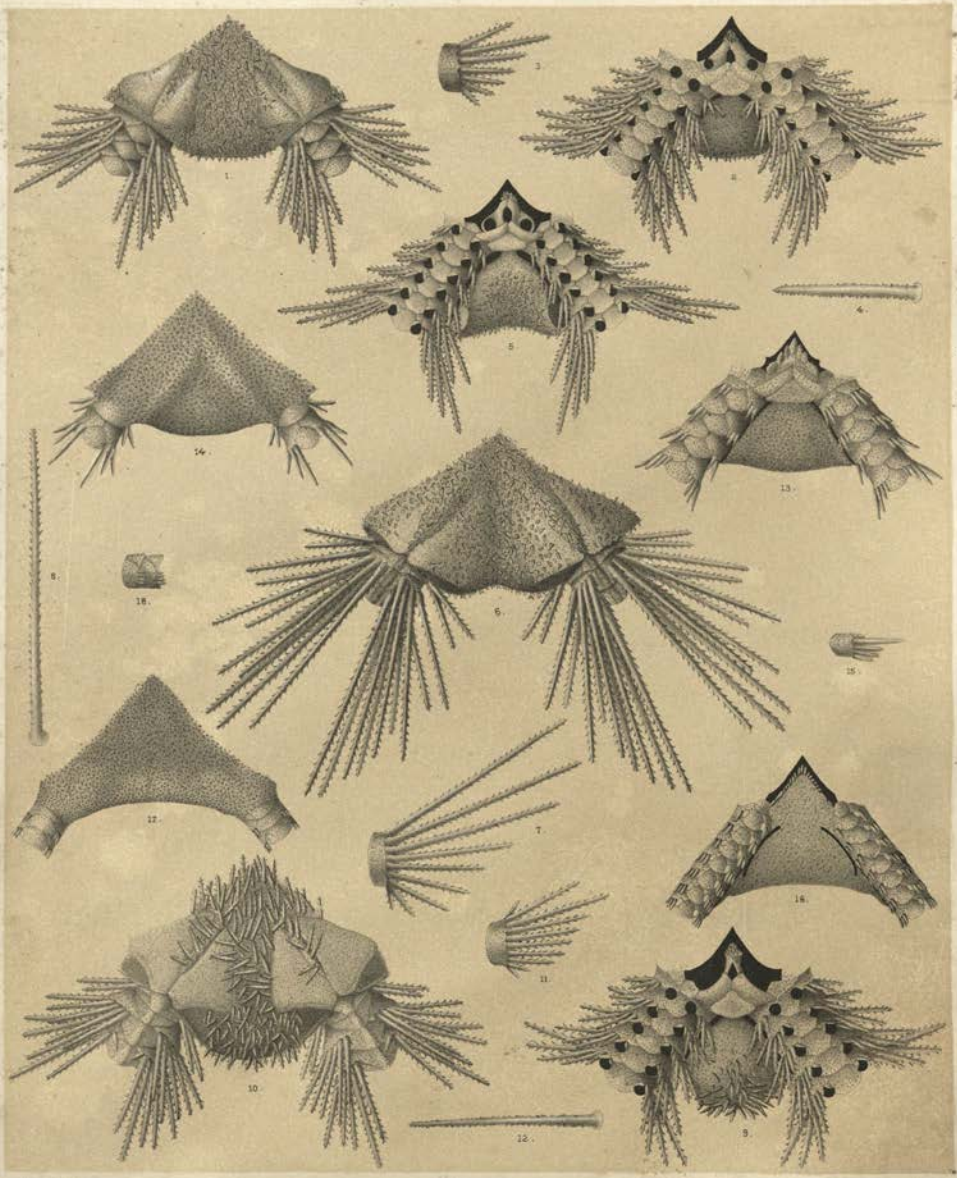
10-12 OPHIOMYCES SPATHIFER. Lym. 13-15 O. GRANDIS. Lym. 16-18 OPHIACTIS CANOTIA. Lym.



Keith Pearson ad nat. Printed by A. Newell

1-3 OPHIACTIS FLEXUOSA. Lym. 4-6 O. HIRTA. Lym. 7-9 O. RESILIENS. Lym.

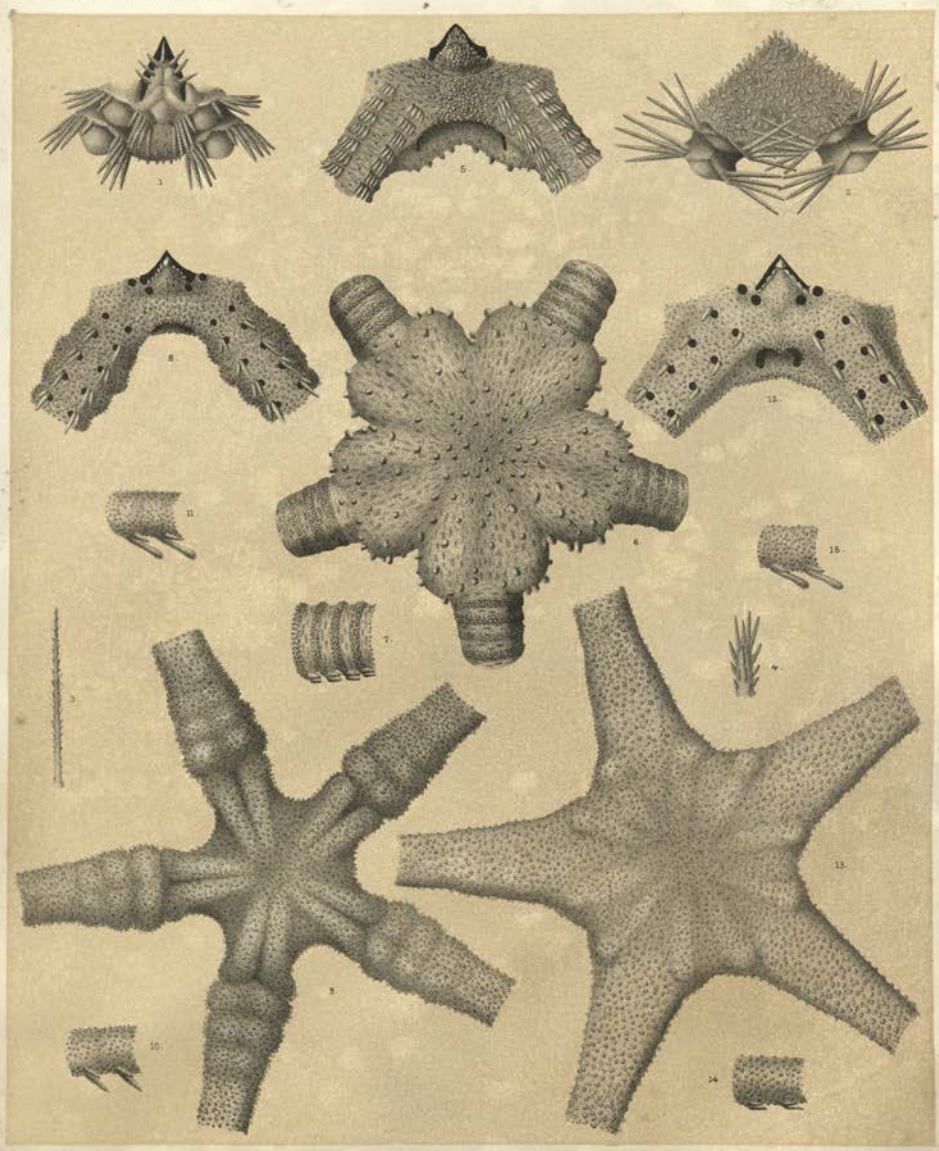
10-12 O. CUSPIDATA. Lym. 13-15 O. POA. Lym. 16-18 O. NAMA. Lym.



L. Dreyfus del. et sculp. Kath. Petersen ad nat. Printed by A. Mittel

1-4. OPHIOTHRIX BERBERIS, Lym. 5-8. O. CAPILLARIS, Lym. 9-12. O. ARISTULATA, Lym.

13-15. OPHIOCRONDRUS STELLIGER, Lym. 16-18. OPHIOPEZA ASTER, Lym.



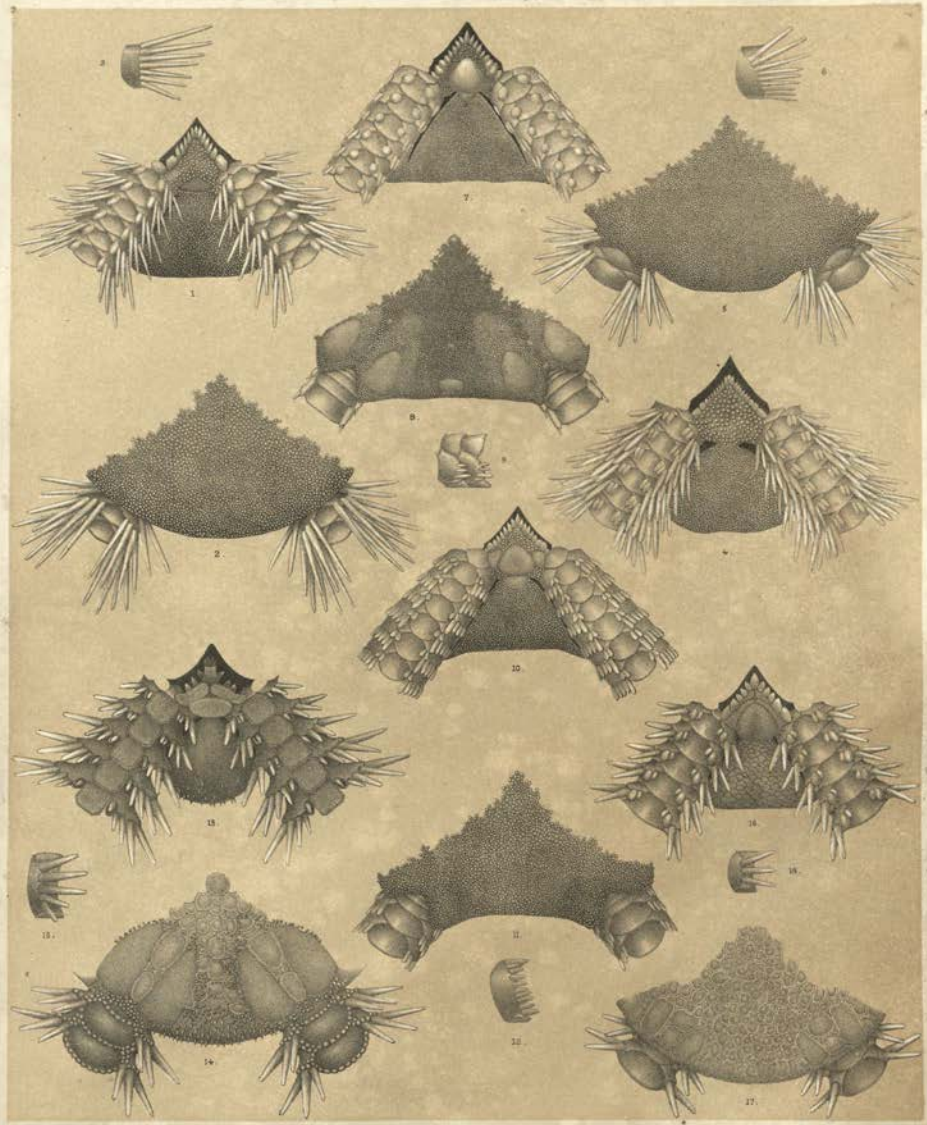
L. Tourcelot sc. et imp.

Each Pattern ad nat.

Printed by A. Meisel

1-4. OPHIACANTHA NODOSA, Lym. 5-7. ASTROTOMA MURRAYI, Lym. 8-11. ASTROSCHEMA TUMIDUM, Lym.

12-15. A. SALIX, Lym.



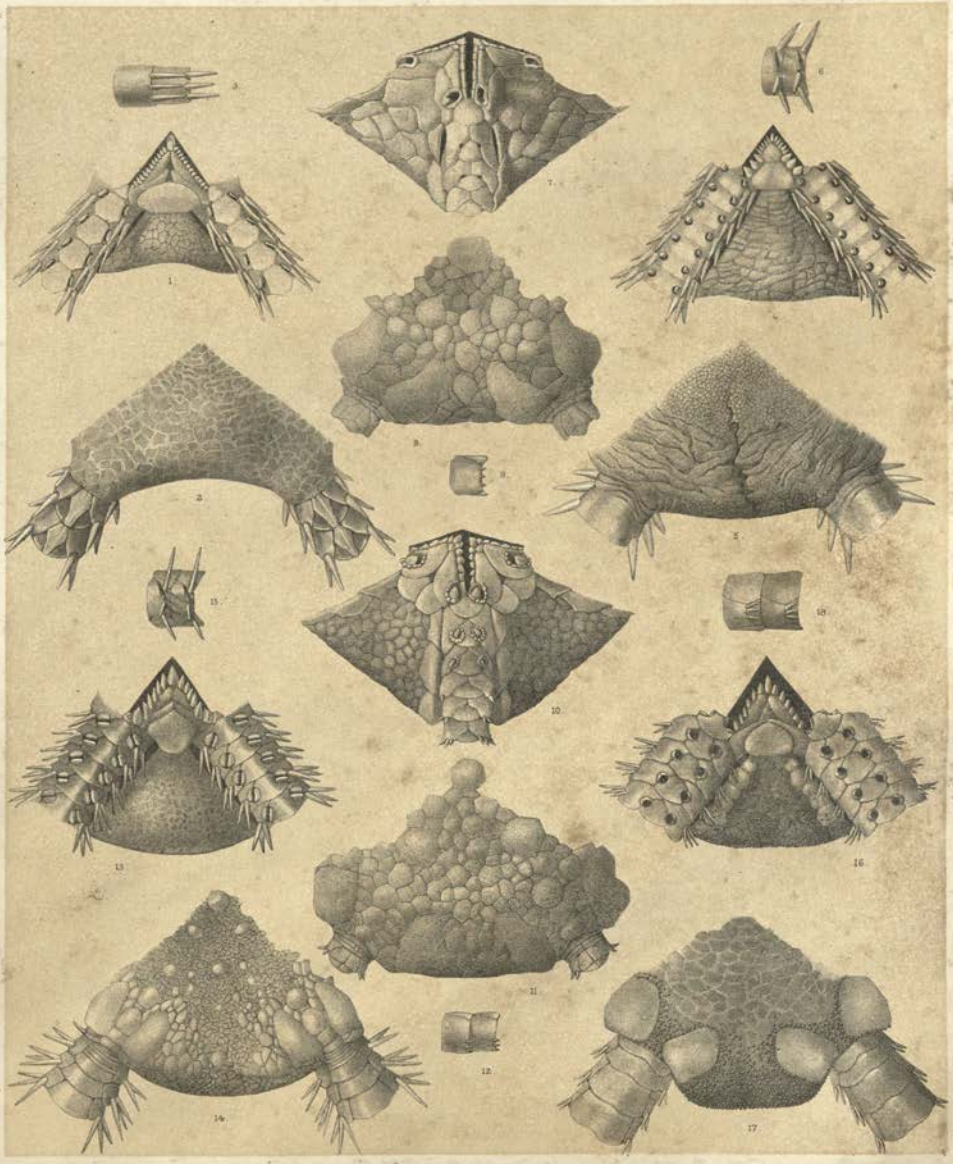
W. Engel on stone

Kath. Patterson ad nat.

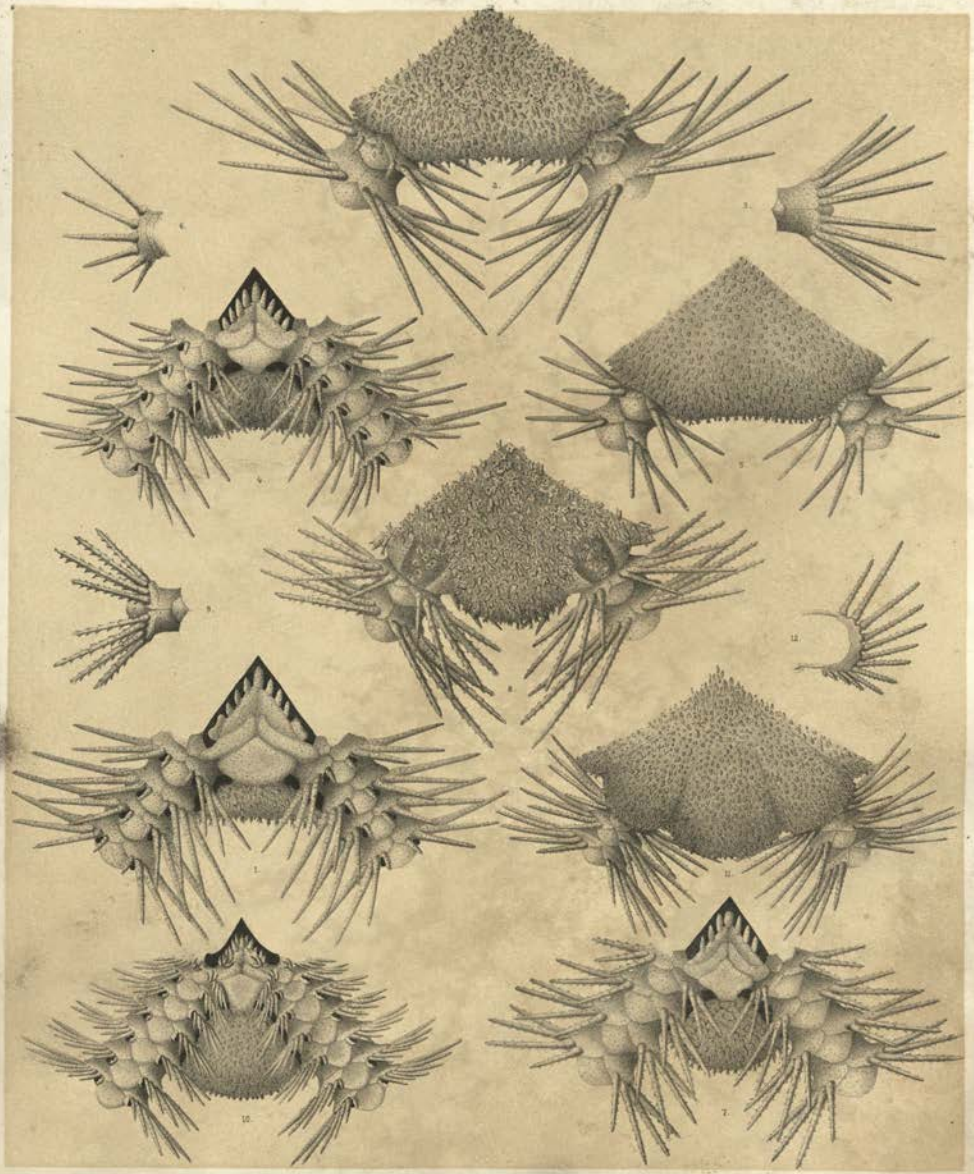
Printed by A. Meisel

1-3 Ophioconis antarctica, Lym. 4-6 O. pulverulenta, Lym. 7-9 Pectinura heros, Lym. 10-12 P. arenosa, Lym.

13-15 Ophiopholis japonica, Lym. 16-18 Ophiochiton lentus, Lym.



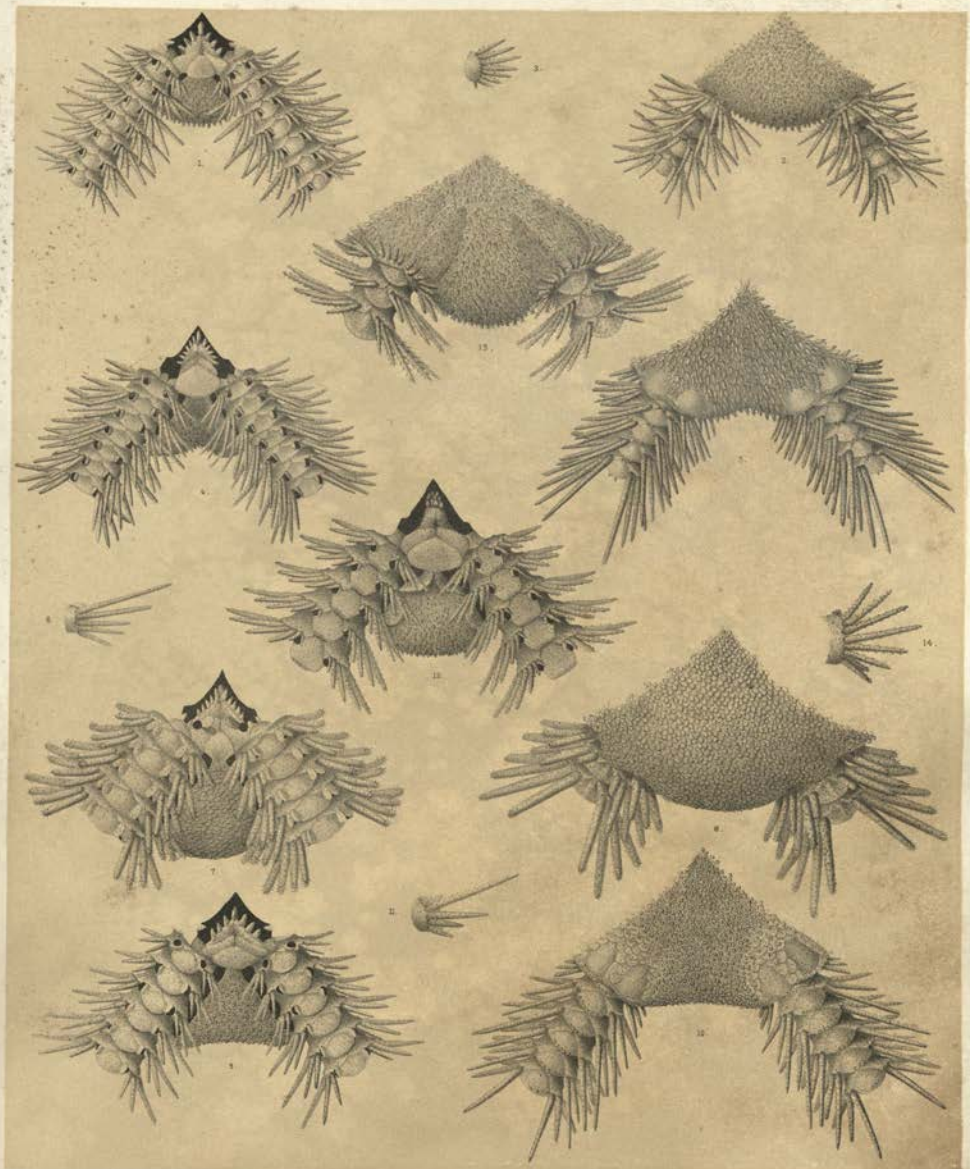
1-3 Ophioscolex tropicus. Lym. 4-6 O. dentatus. Lym. 7-9 Ophioplintrus medusa. Lym. 10-12 O. grisea. Lym.
13-15 Ophiochiton fastigatus. Lym. 16-18 Ophiernus vallincola. Lym.



L. Trautwein sc. et imp.

Printed by A. Mansel

1-3 OPHIACANTHA LEVISPINA, Lym. 4-6 O. IMAGO, Lym. 7-9 O. LONGIDENS, Lym. 10-12 O. ROSEA, Lym.



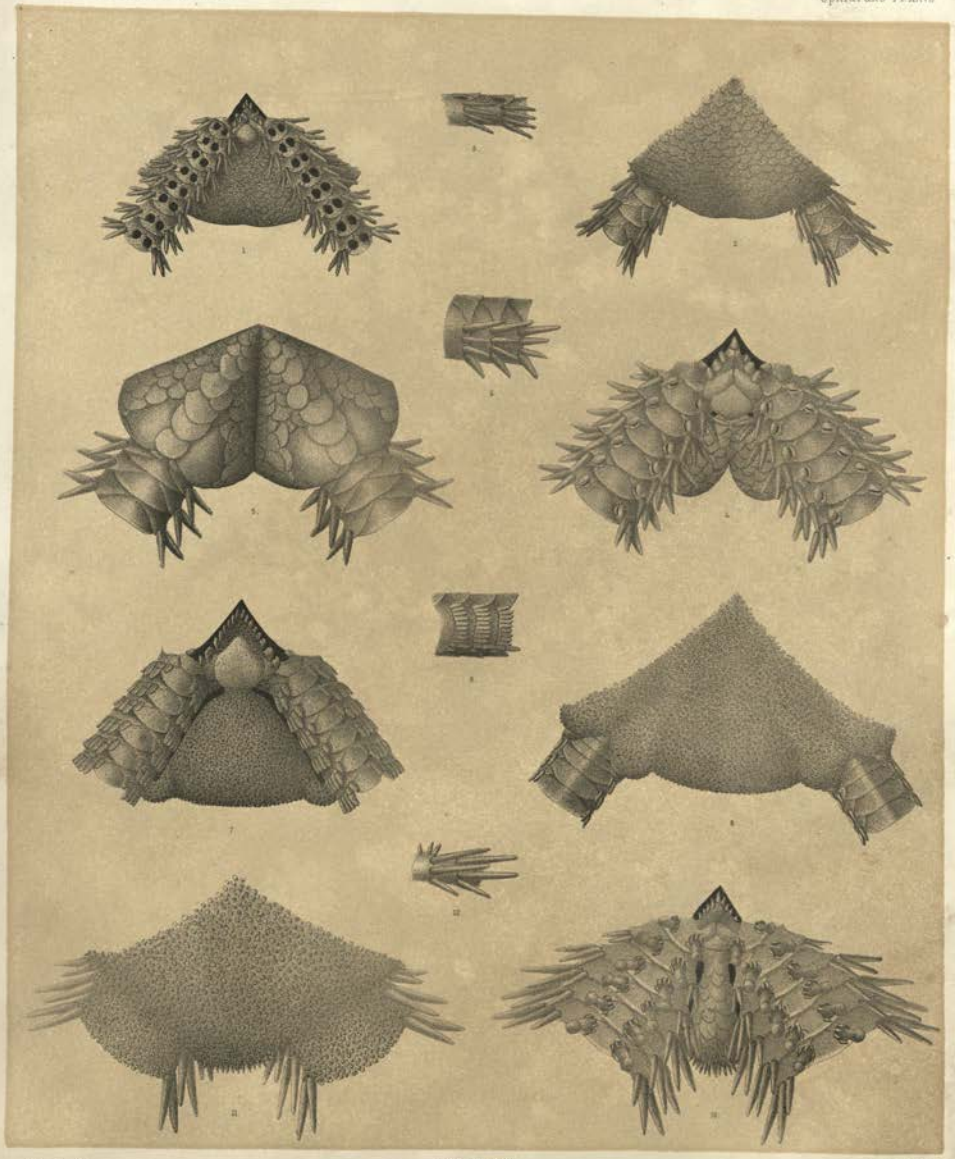
L. Tinnevelot del. et sculp.

Kath. Petersen ad nat.

Printed by A. Moore

1-3. OPHIACANTHA DISCOIDEA, Lym. 4-6. O. ARNORMIS, Lym. 7-8. O. VALENCIENNESI, Lym. 9-11. OPHIOMITRA NORMANI, Lym.

12-14. OPHIATHRIX CÆSPITOSA, Lym.



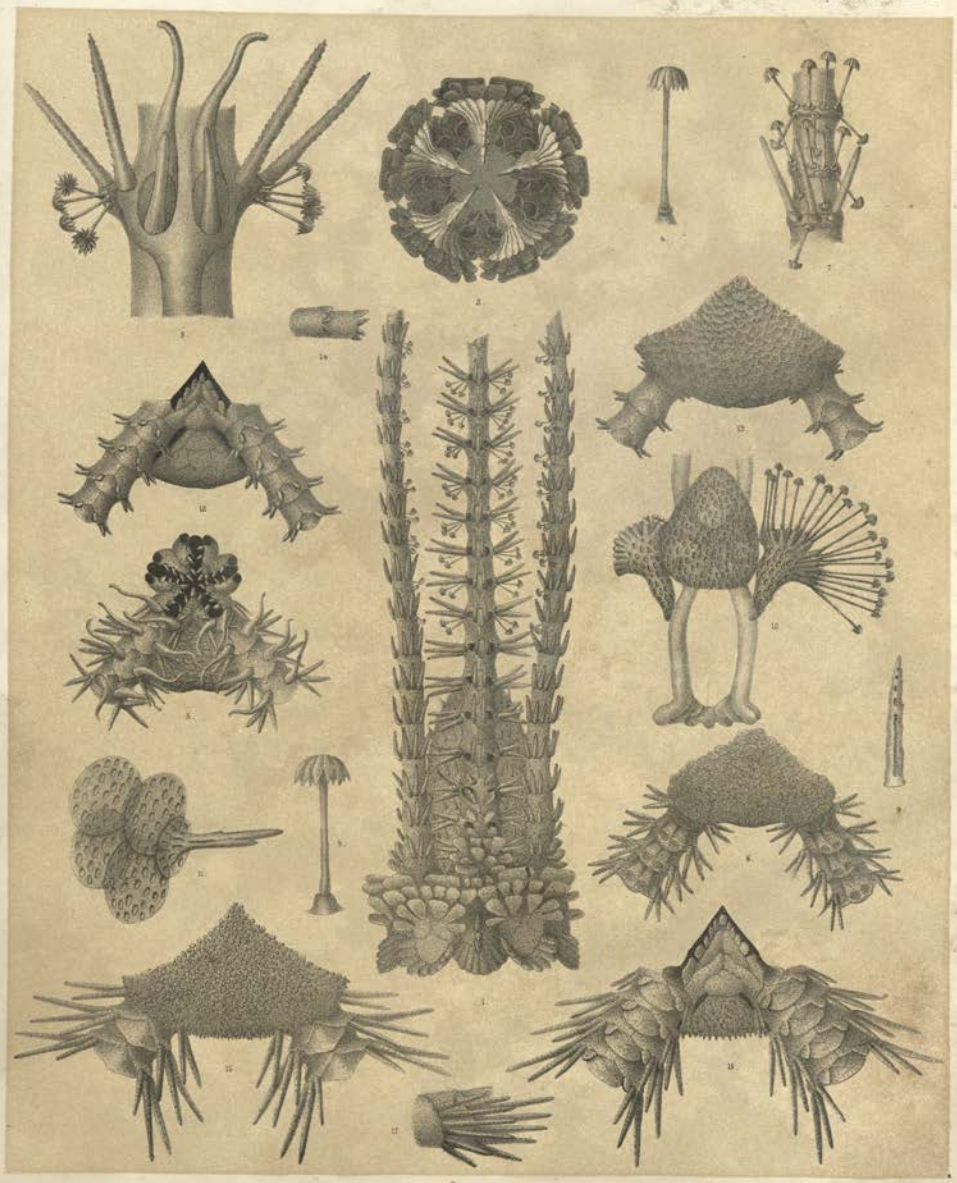
L. Tavernier del. et sculp.

Keith Pearson ad nat.

Printed by Adlard

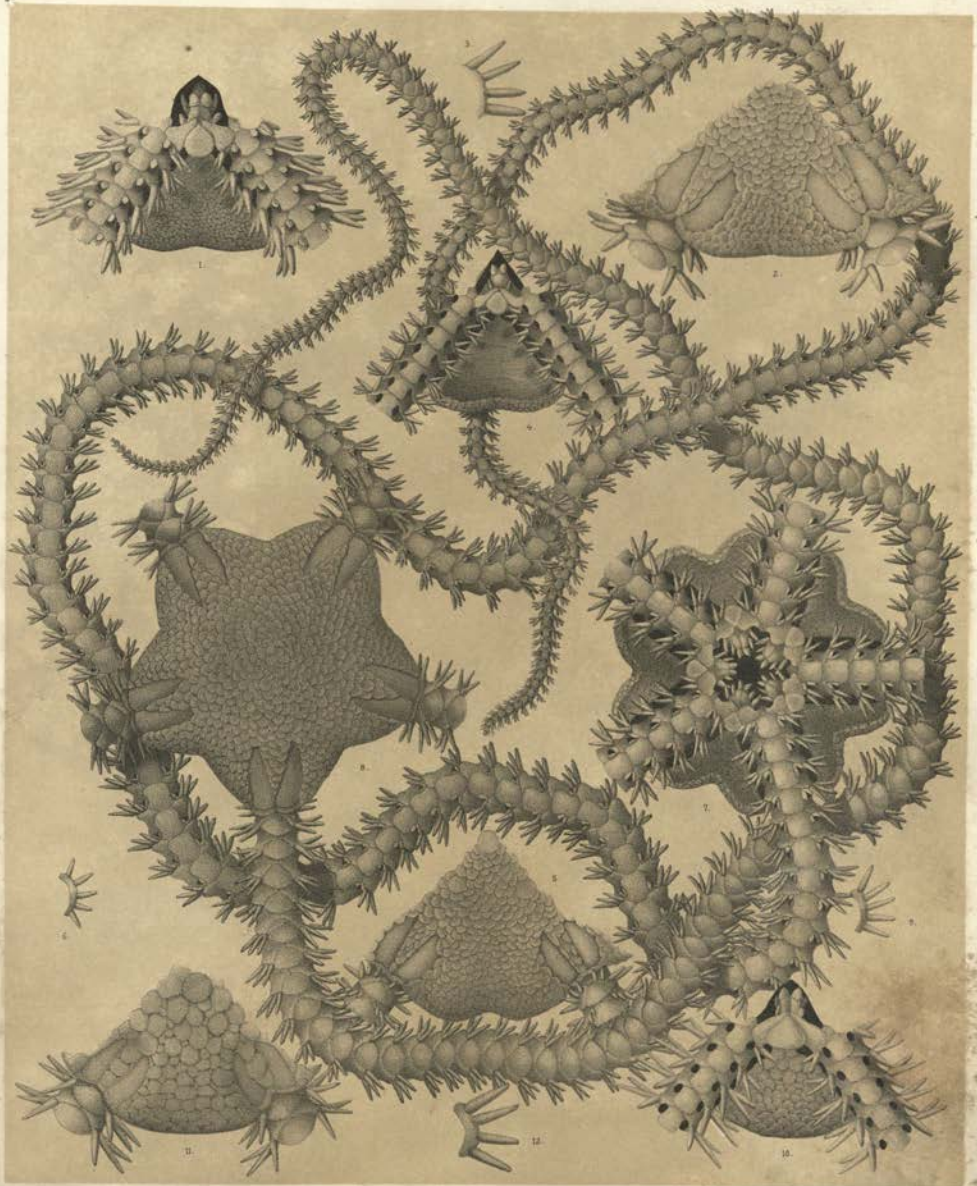
1-3 OPHIOCYMBIUM CAVERNOSUM. Lym. 4-6 OPHIACTIS PECTORALE. Lym. 7-9 OPHIOPEZA AEQUALIS. Lym.

10-12 OPHIAMBIX ACULEATUS. Lym.



1-4 OPHIOTROLIA SUPPLICANS. Lym. 5-9 OPHIOREIUS PELLUCIDUS. Lym. 10-11 OPHIOREIUS UMBELLA. Lym.

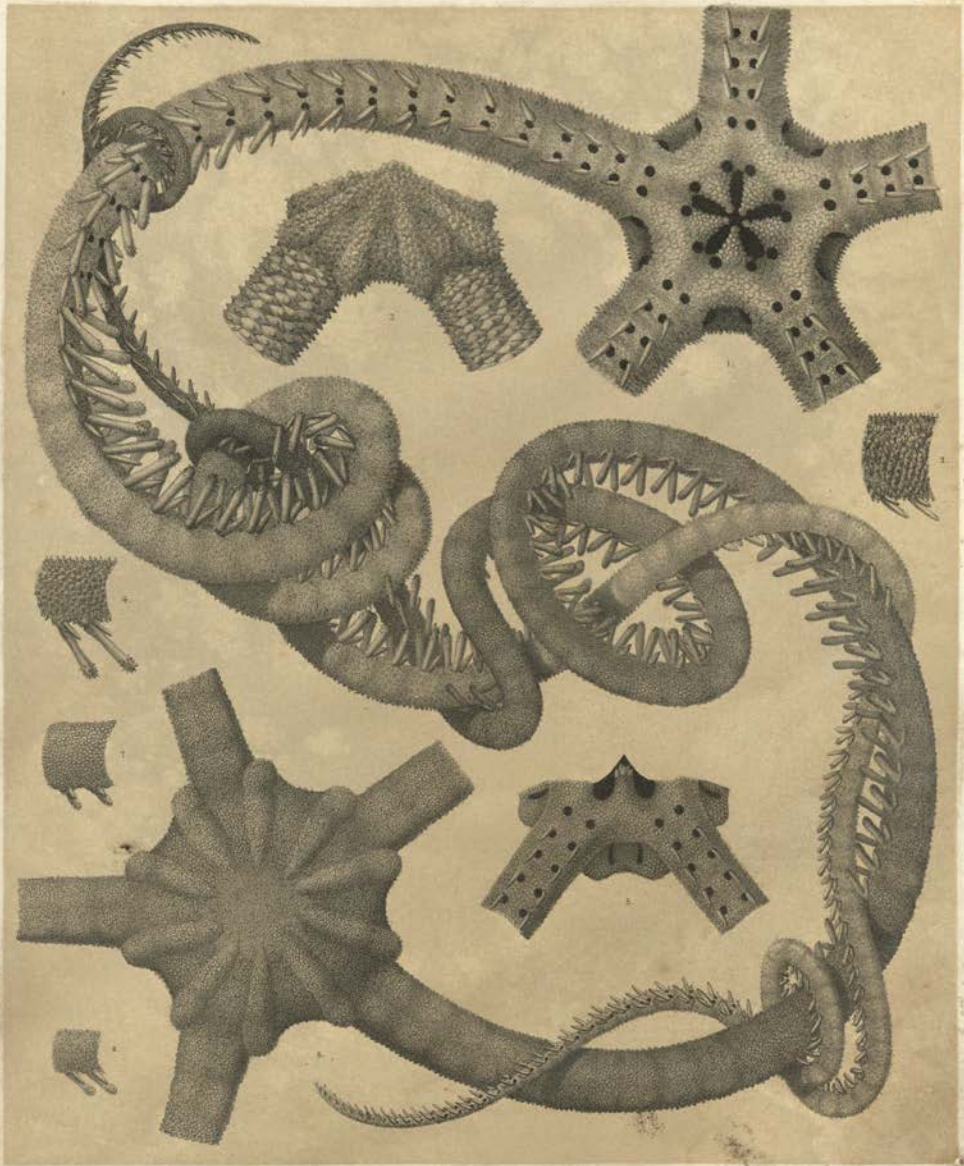
12-14 OPHIOCHYTRA EPIGRUS. Lym. 15-17 OPHIACANTHA PLACENTIGERA. Lym.



L. Trouvelot ad nat. del.

Printed by A. Maland.

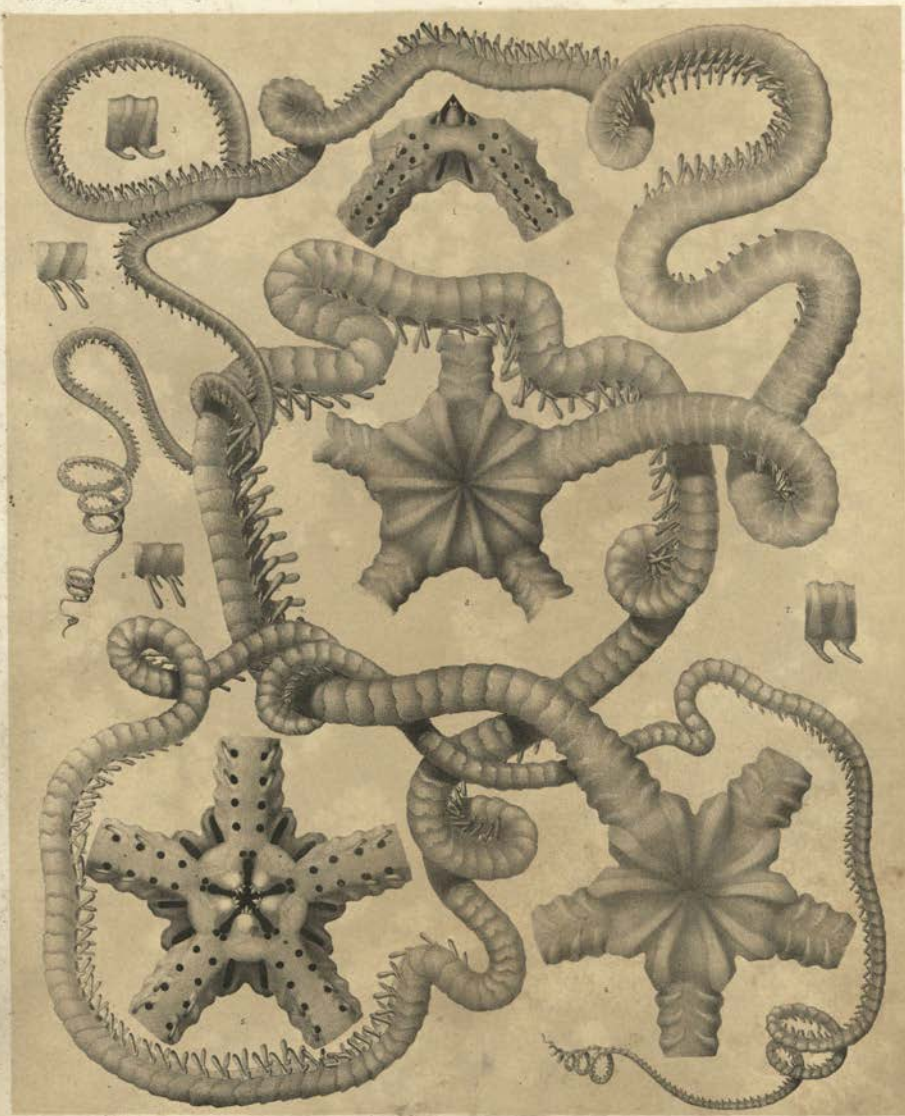
1-3. AMPHIURA ANGULARIS, Lym. 4-6. A. DILATATA, Lym. 7-9. A. LANCEOLATA, Lym. 10-12. A. TOMENTOSA, Lym.



J. Stanislas sc. Paris

Printed by A. Maison

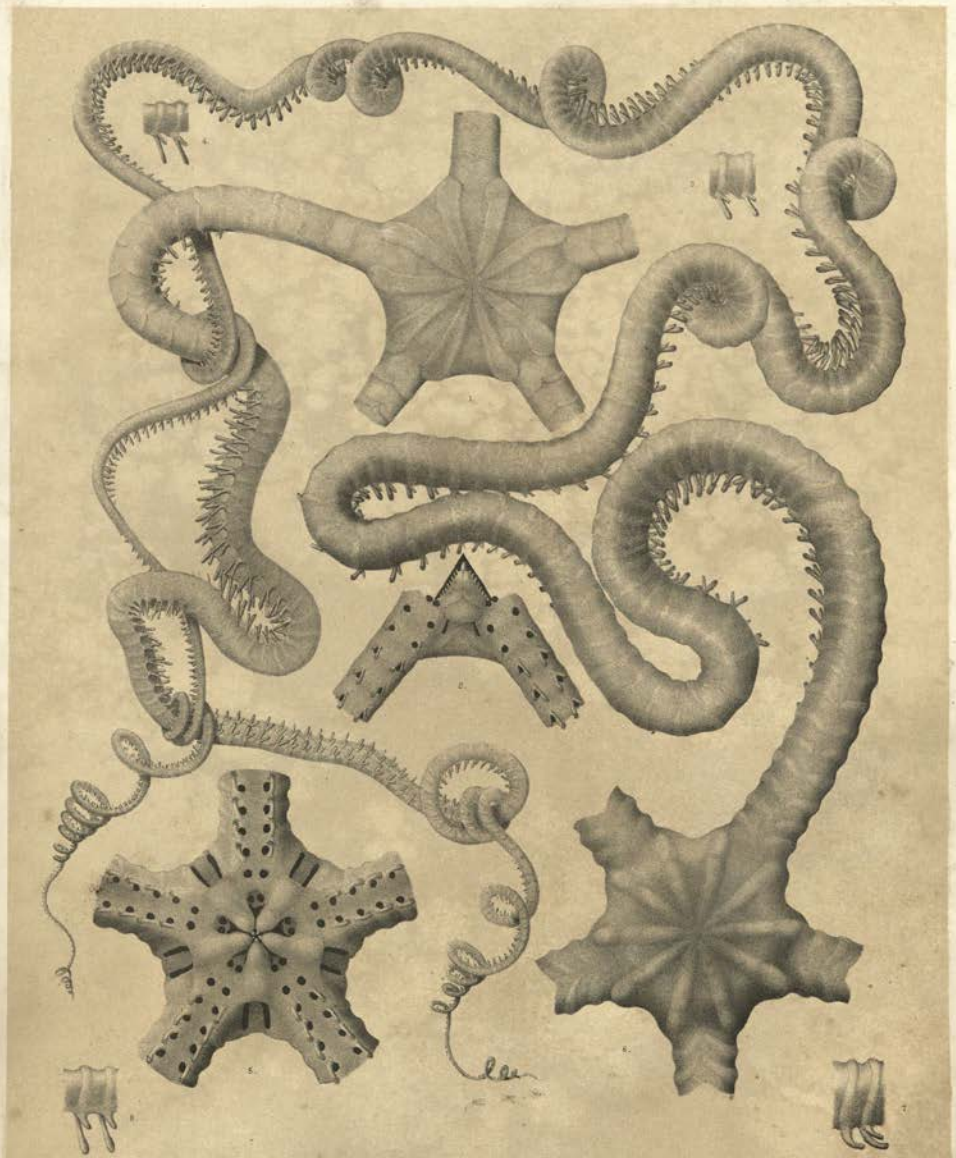
1-4 ASTROSCHEMA HORRIDUM. Lym. 5-8 ASTROSCHEMA BRACHIATUM. Lym.



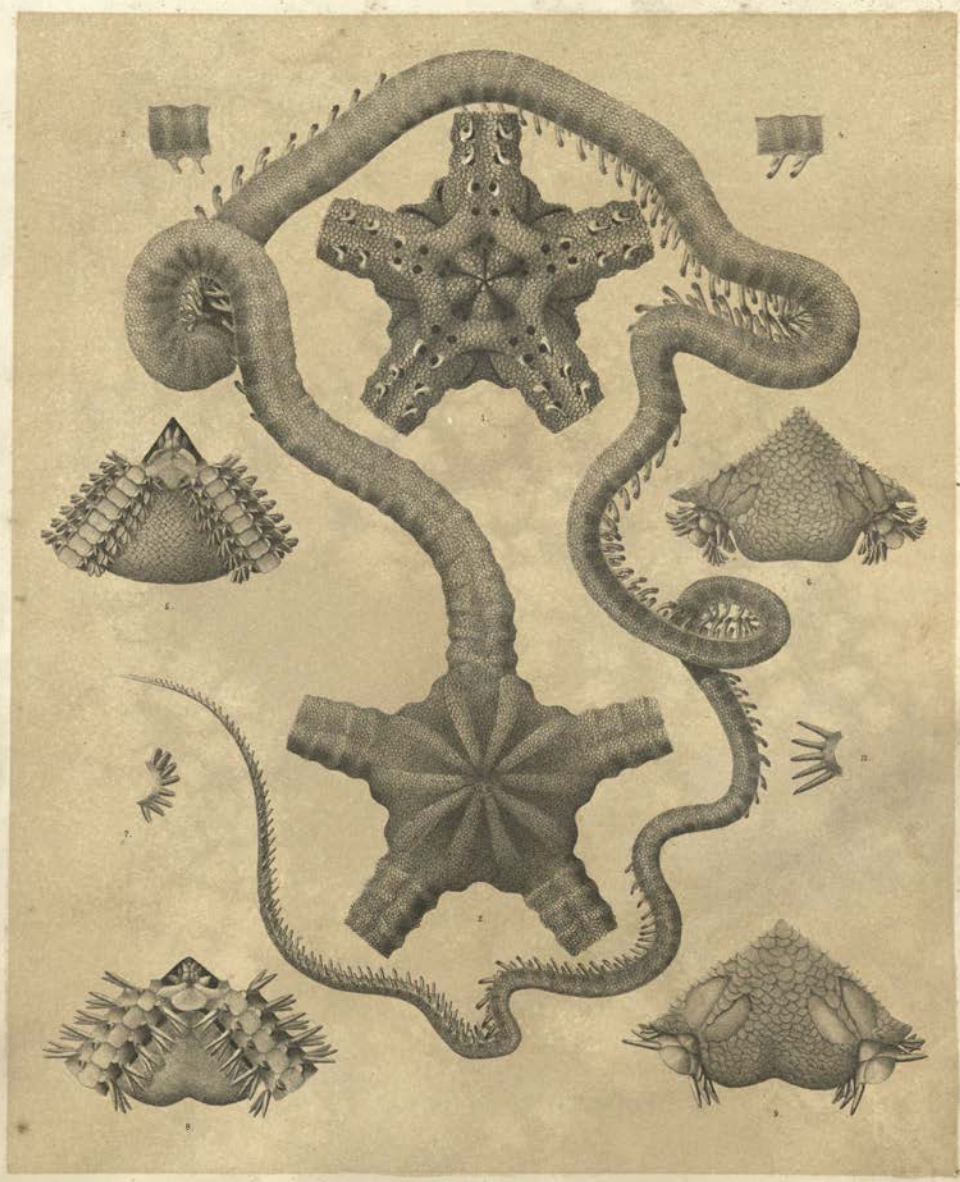
J. Tennant del. et sculp.

Printed by A. Mason

1-4 OPHIOCREAS CARNOSUS, lym. 5-8 O. ŒDIPUS, lym.



1-4 OPHIOCREAS ABYSSICOLA, Lym. 5-8 O. CAUDATUS, Lym.

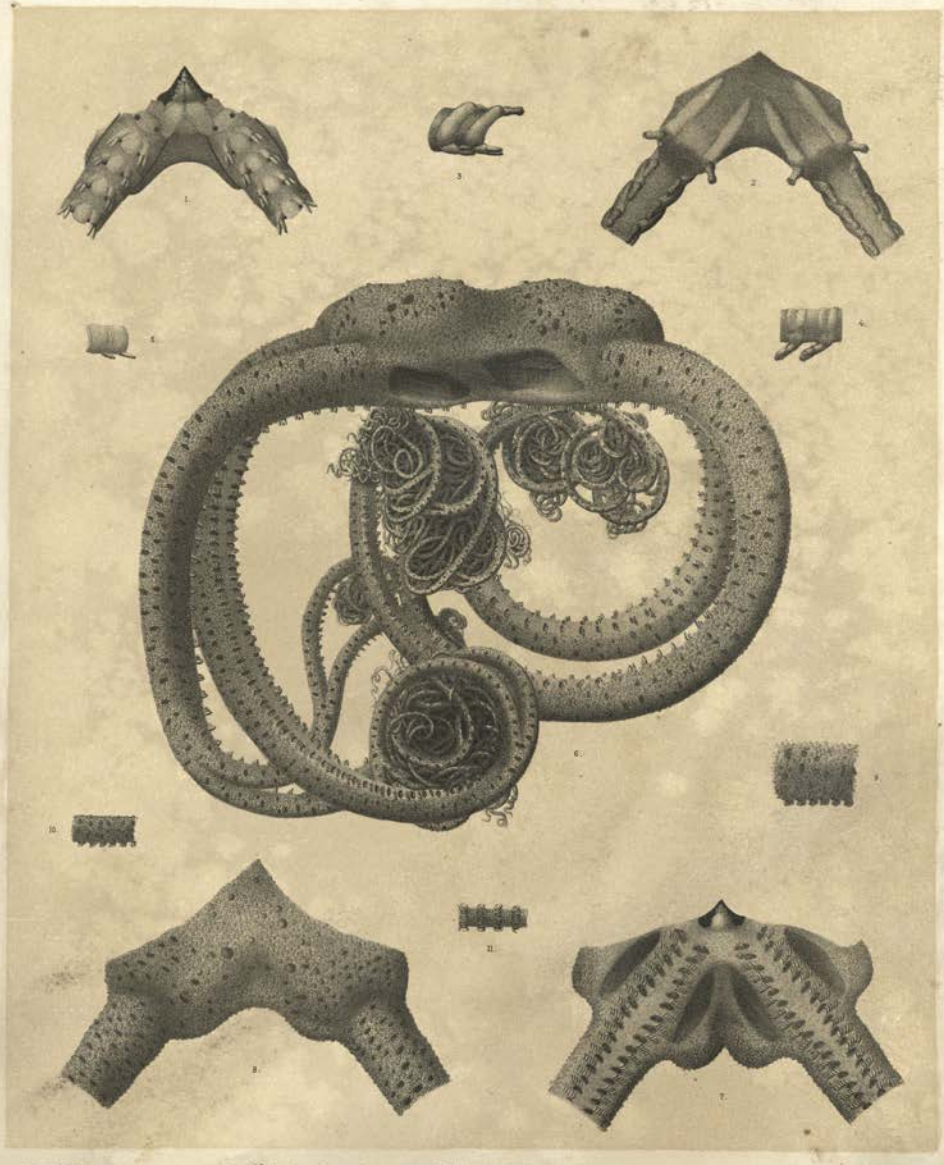


T. Trouvelot sc. et imp.

Kath. Pearson ad nat.

Printed by A. Maisel.

1-4 ASTROSCHEMA RUBRUM. Lyon. 5-7 AMPHIURA INCANA Lyon. 8-10 A. GLABRA. Lyon.

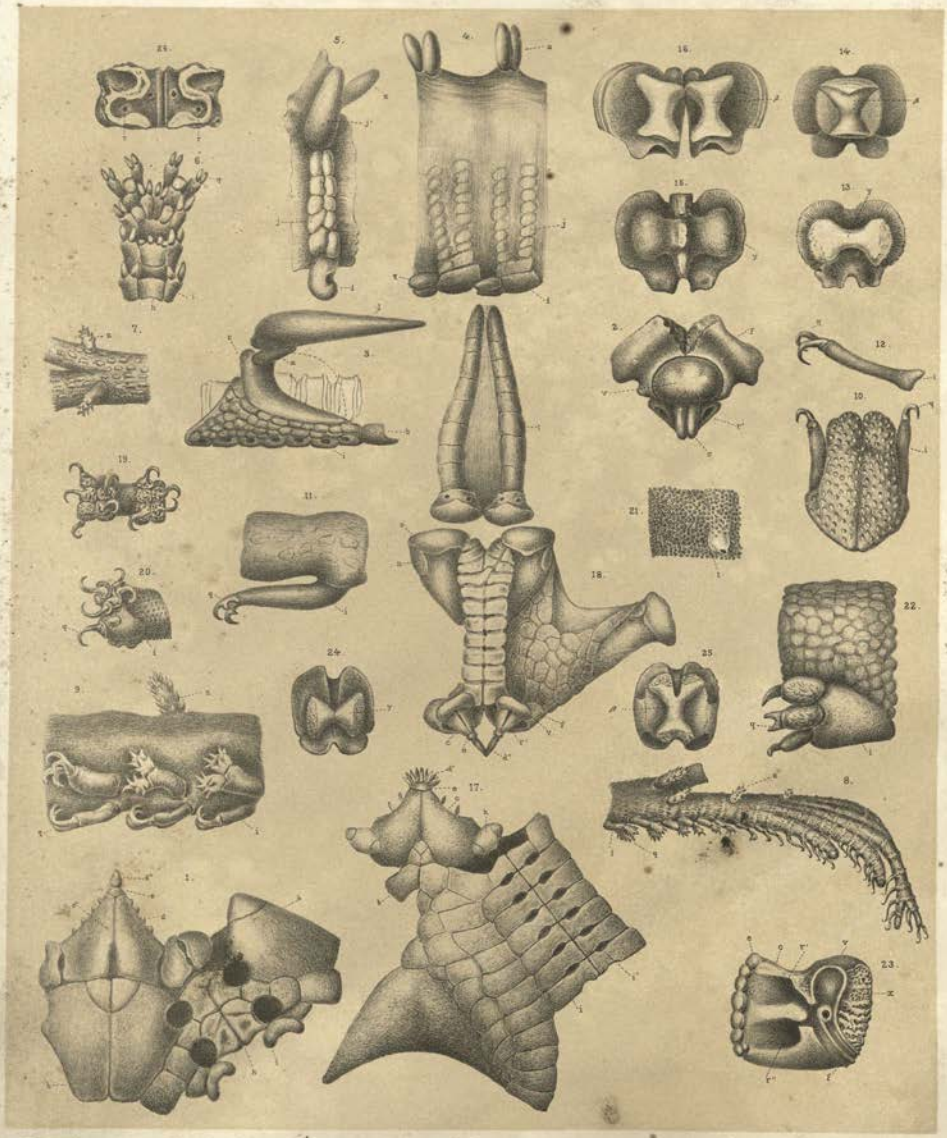


J. Trouvelot ad vivum

Kath. Peirson ad nat.

Printed by A. Mansel

1-5 ASTROCERAS PERGAMENA. Lym. 6-11 ASTROCLON PROPUGNATORIS. Lym.

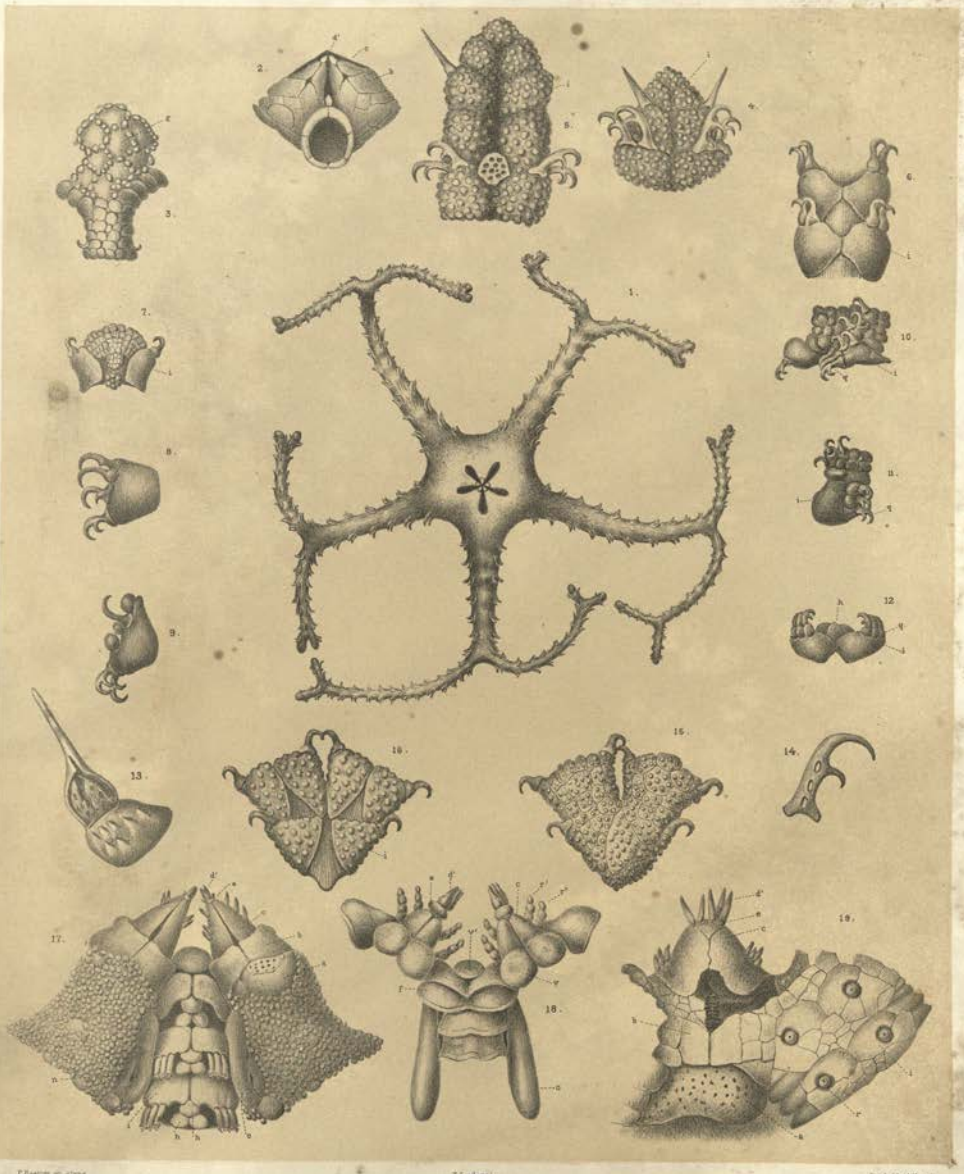


F. Kaiser sc. chem.

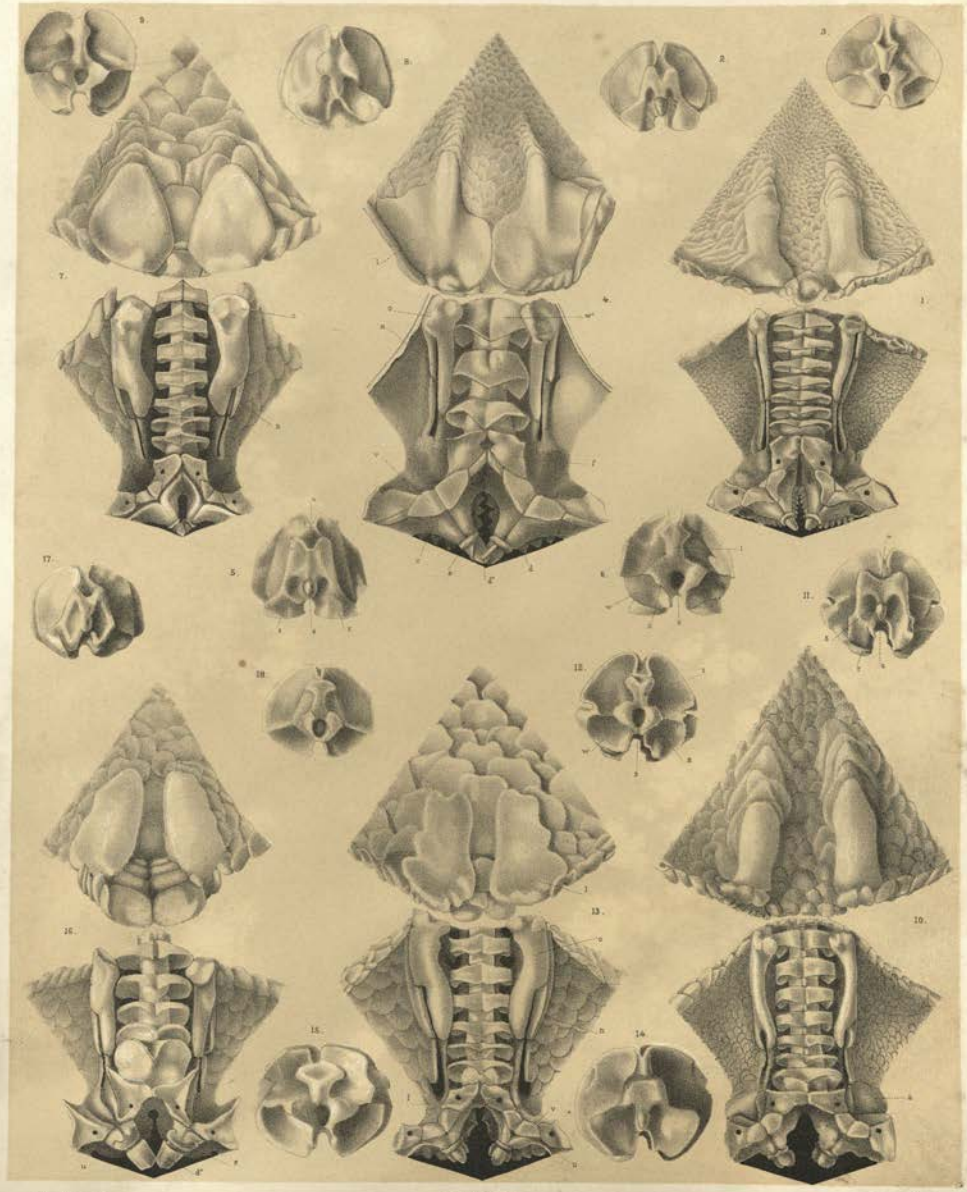
T. L. ad. nat.

Printed by A. Meisel

1-16 EURYALE ASPERA, Lmk. 17-26 ASTROPHYTON COSTOSUM Sebs.



GORGONOCEPHALUS AGASSIZII, Lym.



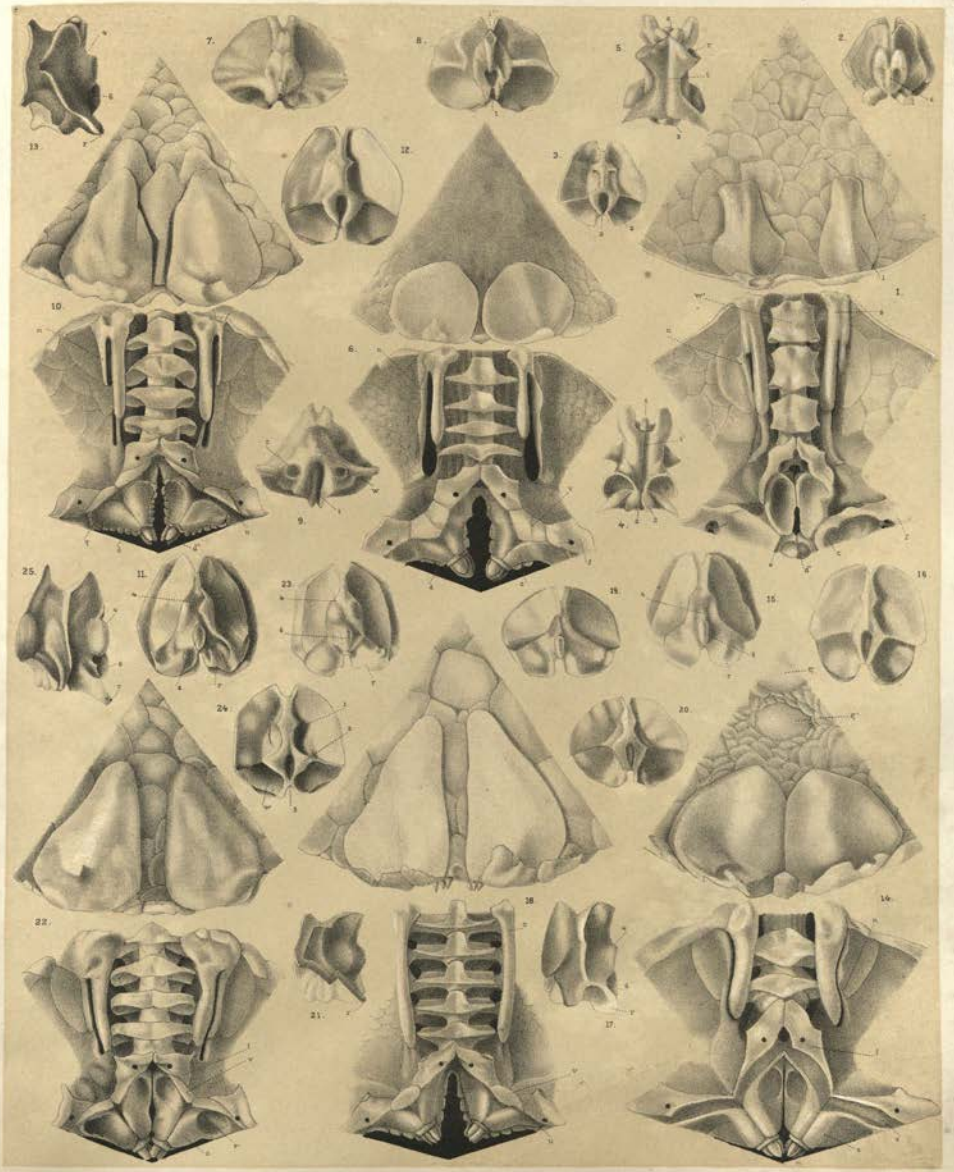
L. Bourdier ad vivum

Kath. Petrowa ad nat.

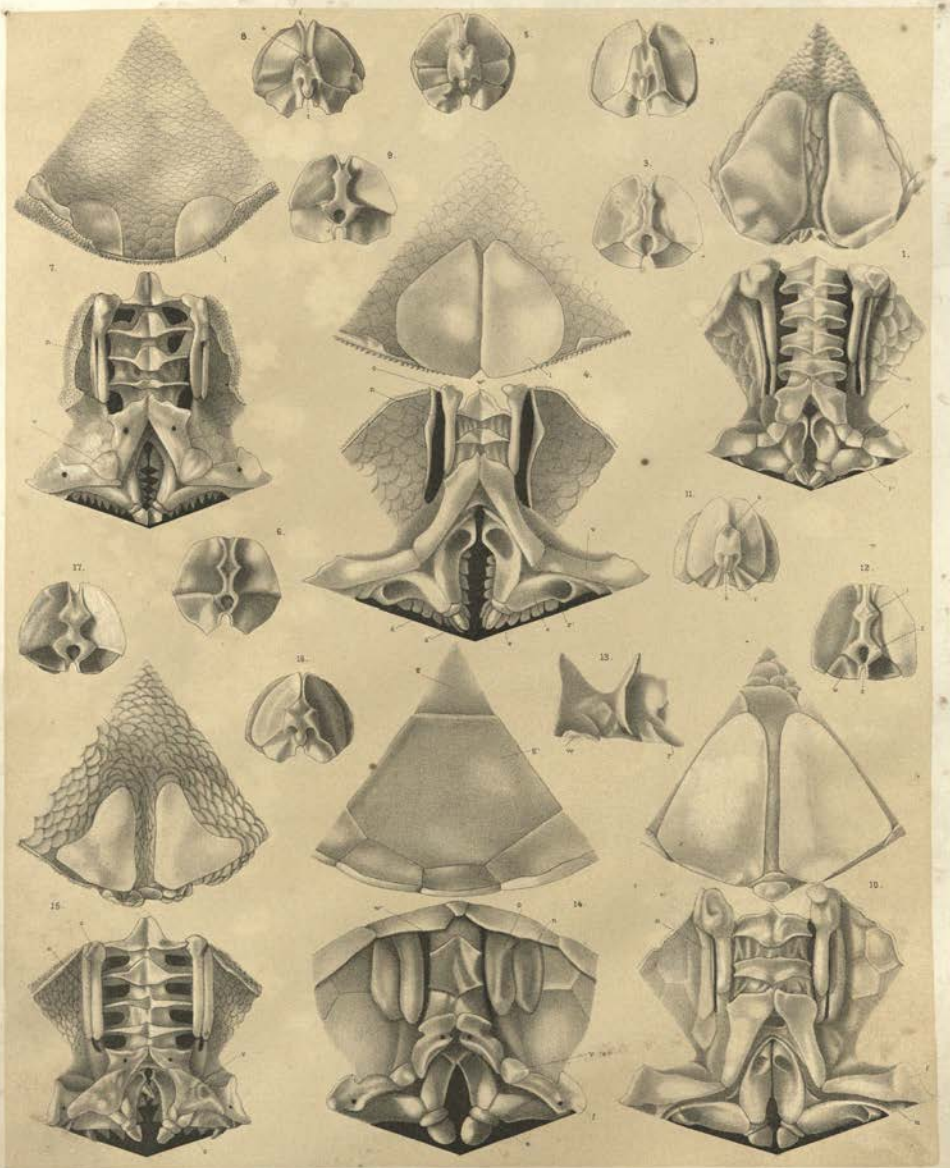
Printed by A. Mansel

1-3. OPHIURA ELAPS Ob. Lym. 4-6. OPHIOPÆPALE GOESIANA, Ljn. 7-9. OPHIOLEPIS CINCTA, Müll. & Tr.

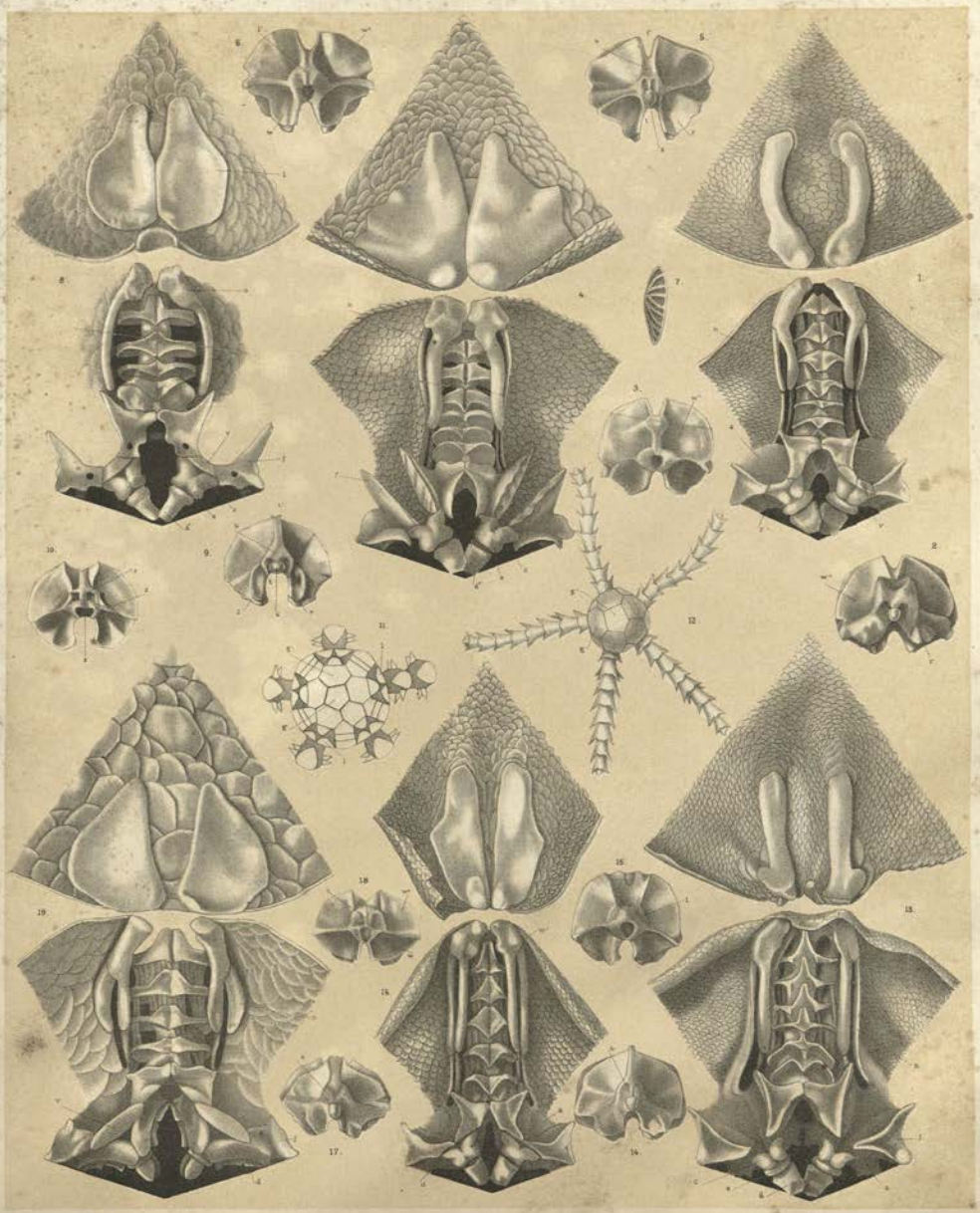
10-12. OPHIOPLOCUS IMBRICATUS, Lym. 13-15. OPHIOZONA IMPRESSA, Lym. 16-18. OPHIOCERAMIS JANUARII, Lym.



1-5. OPHIOPLINTHUS MEDUSÆ, Lym. 6-9. OPHIERNUS VALLINCOLA. Lym. 10-13. OPHIOGLYPHA LYMANI. Ljn.
14-17. O. BULLATA, Wyv. Thom. 18-21. OPHIOCTEN SERICEUM. Lym. 22-25. OPHIOGLYPHA DESBAYESI. Lym.



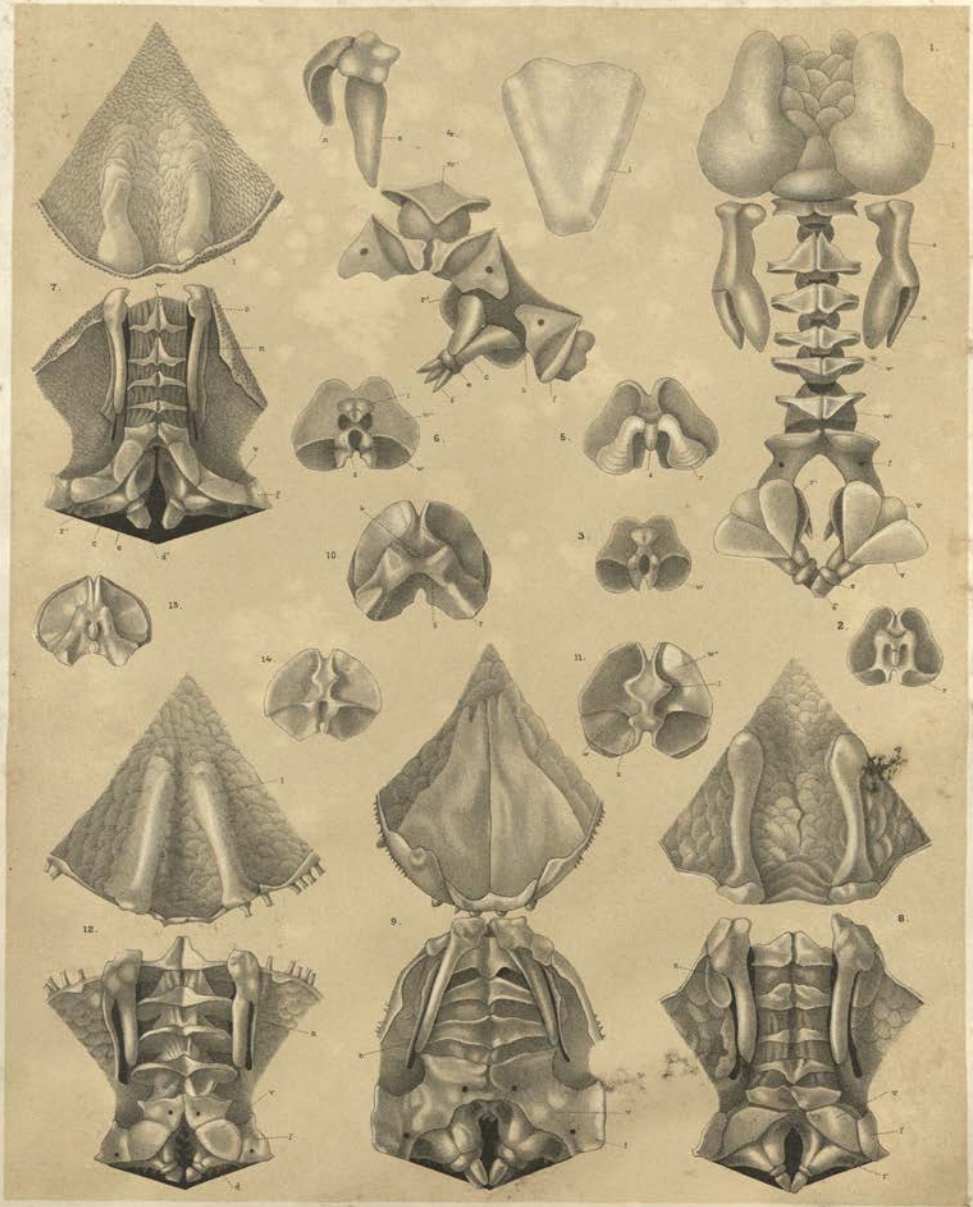
1-3. OPHIOLIPUS AGASSIZII. Lym. 4-6. OPHIOPYREN LONGISPINUS. Lym. 7-9. OPHIOCONIS MILIARIA. Lym.
10-13. OPHIOMUSIUM SERRATUM. Lym. 14. OPHIOMASTUS SECUNDUS. Lym. 15-17. OPHIOCHOTA MIXTA. Lym.



J. Stengelen sc. Lith. Kath. Paterson ad nat. Printed by A. Meisel.

1-3. OPHIOPSILA RIISEI, Lth. 4-7. OPHIOPHRAGMUS WURDEMANI, Lym. 8-12. HEMIPHOLIS CORDIFERA, Lym.

13-15. OPHIONEREIS RETICULATA, Lth. 16-18. AMPHIURA BELLIS, Lym. 19. AMPHILEPIS NORVEGICA, Lyn.



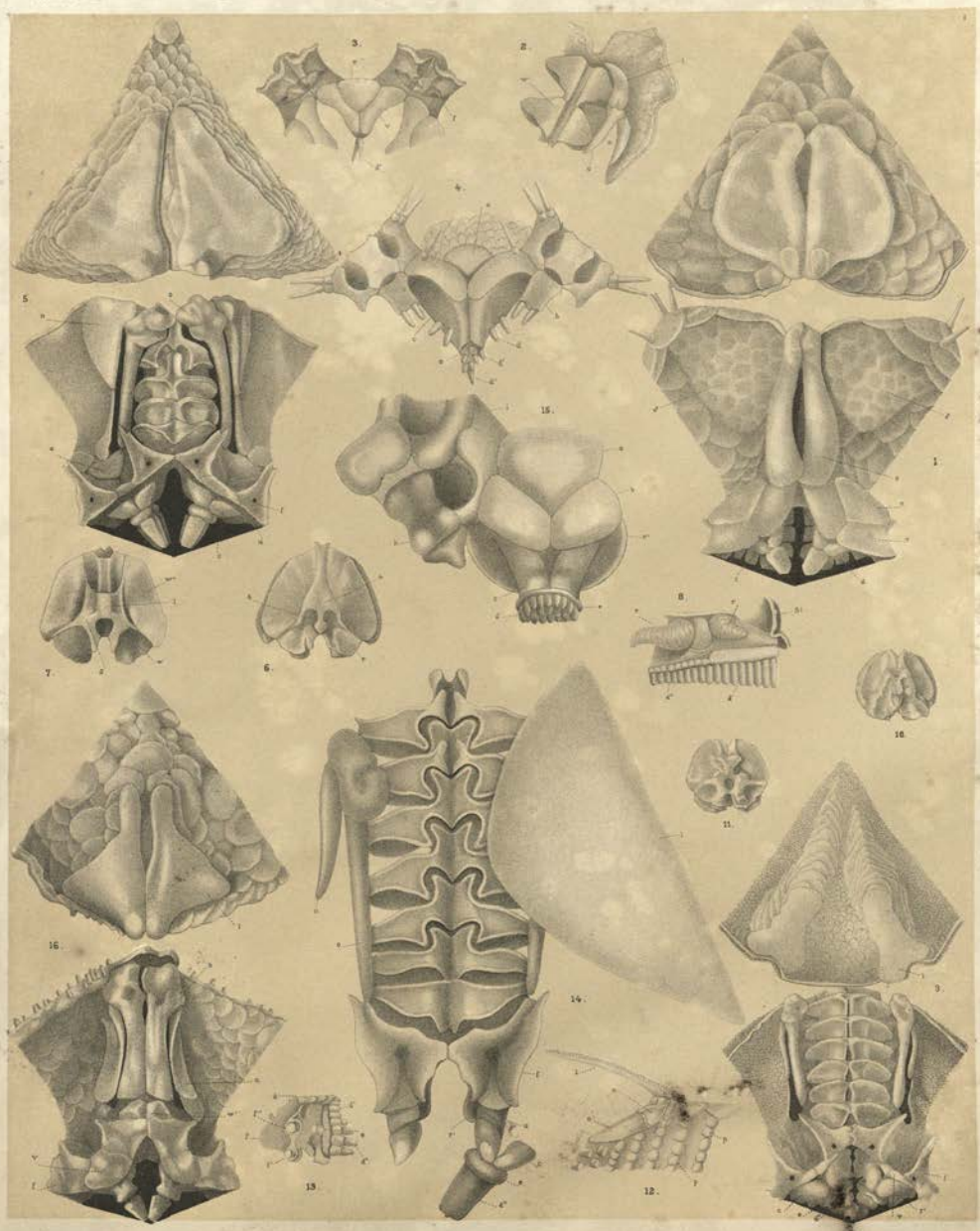
L. Brousselet sc. et imp.

Keith Pearson & T. L. ad nat.

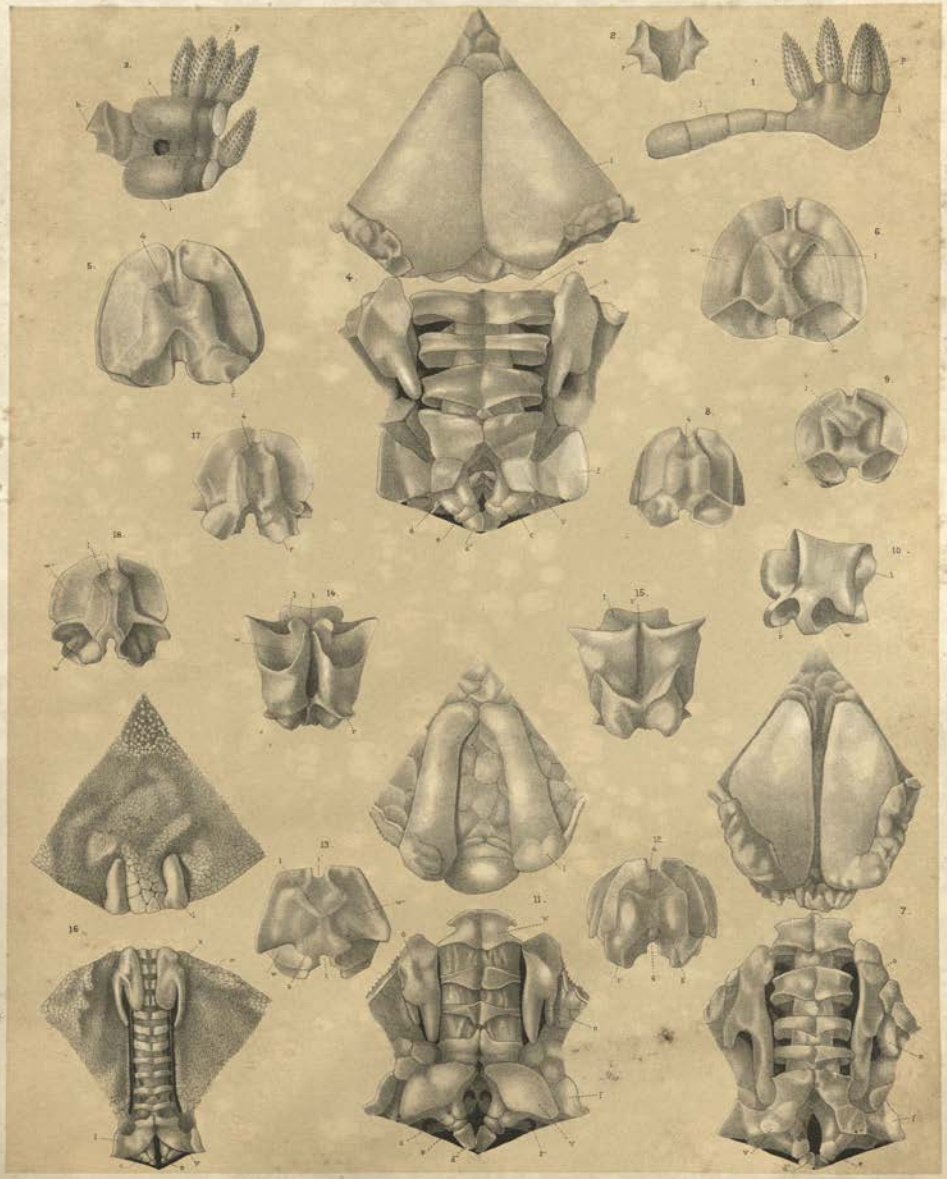
Printed by A. Mansel

1-3. OPHIOPEZA FALLAX, Pet. 4-6. OPHIOMITRA VALIDA, Lym. 7. OPHIOPLAX LJUNGMANI, Lym. 8. OPHIOLEBES SCORTEUS, Lym.

9-11. OPHIOCAMAX HYSTRIX, Lym. 12-14. OPHIACANTHA CUSPIDATA, Lym.

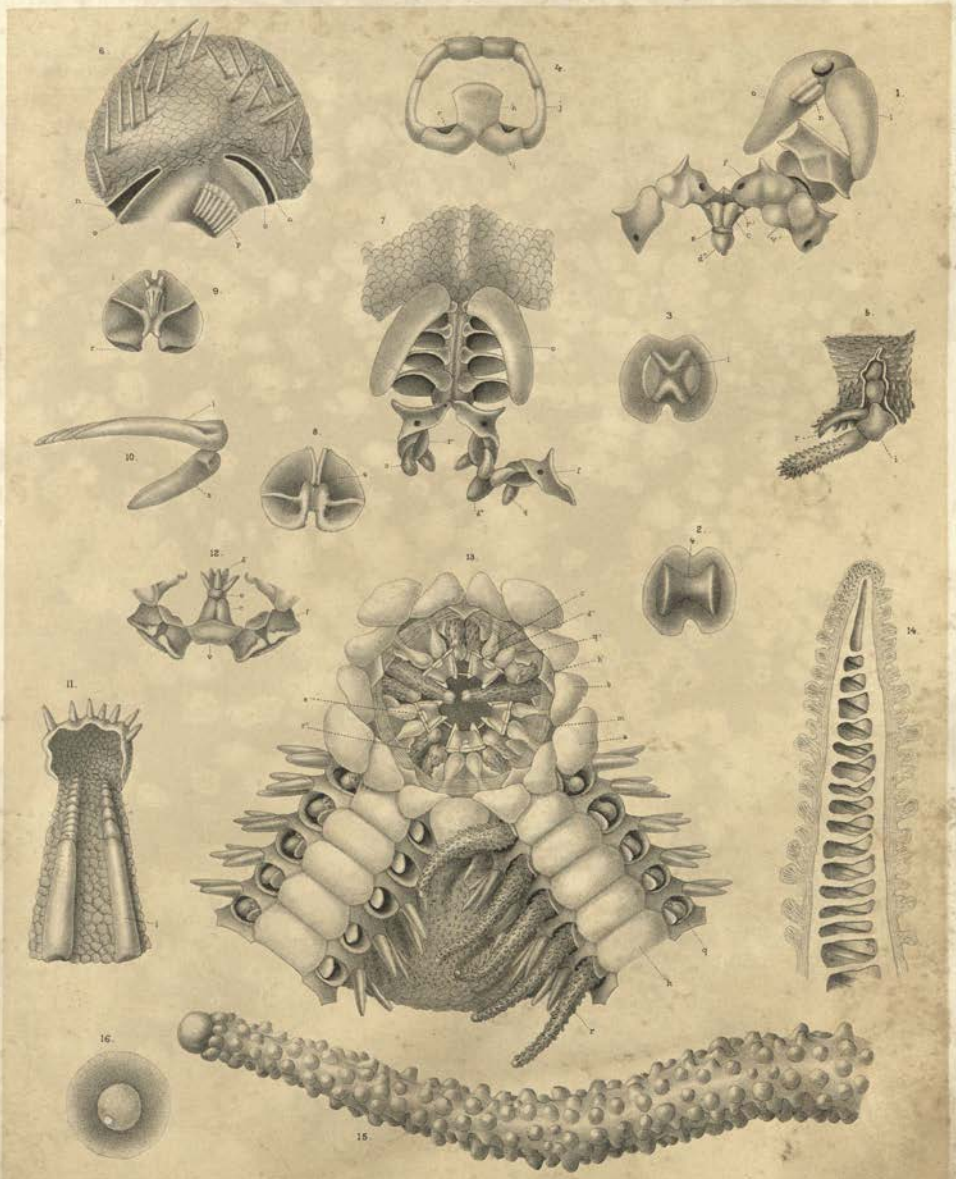


1. Ophiothamnus vicarius, Lym. 2-4. Ophioscolex glacialis, Müll. & Tr. 5-8. Ophiothrix quinquemaculata, Müll. & Tr. 9-11. Ophiocoma Æthiops, Lütk.
12-13. Ophiocoma echinata, Agass. 14-15. Ophiochemis marmorata, Müll. & Tr. 16. Ophiostigma isacanthum, Lym.



1-3. Ophiomyxa flaccida, Lyk. 4-6. Sigsbeia murrhina, Lym. 7-10. Hemieuryale pustulata, V. Mart.

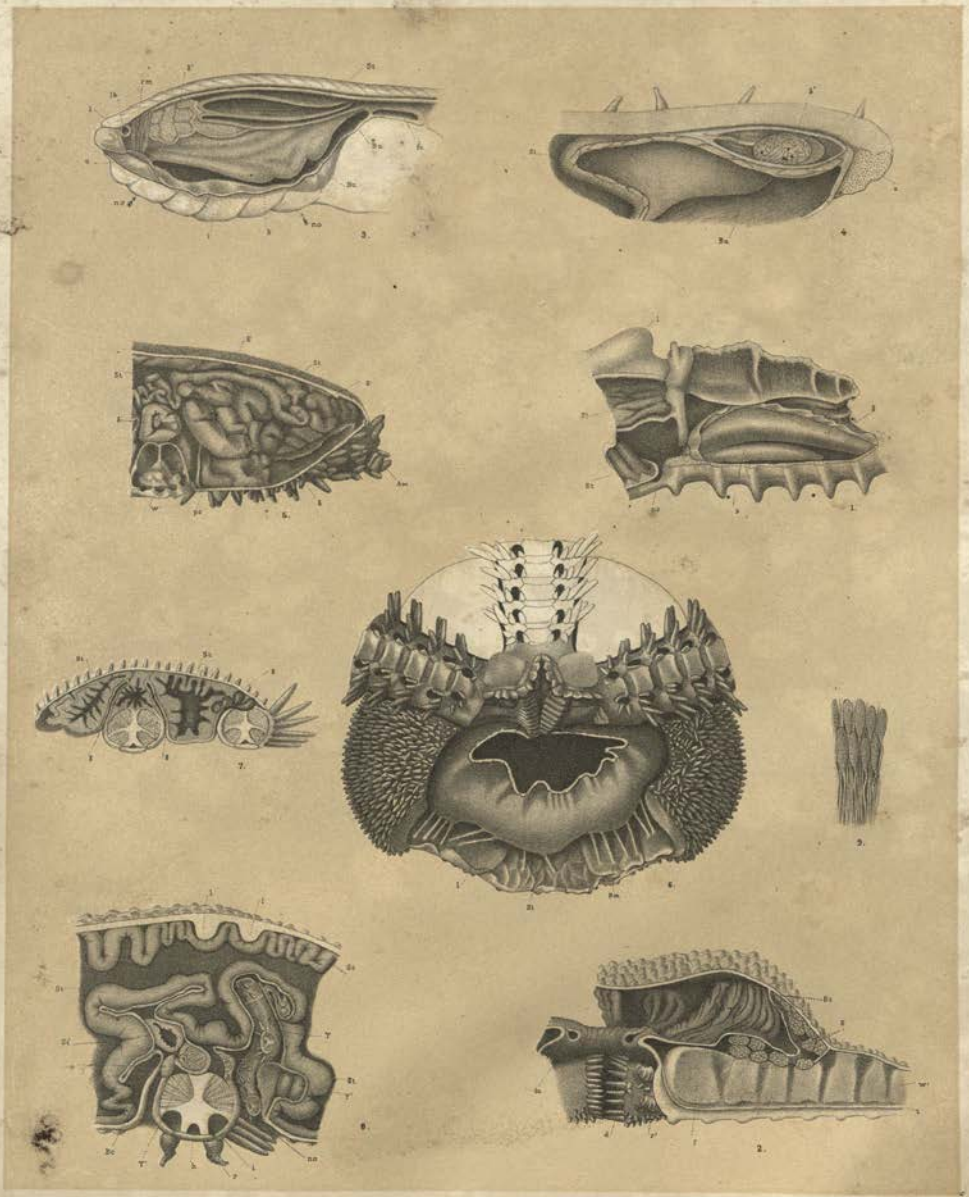
11-15. Ophiochondrus convolutus, Lym. 16. Ophiobyrsa rudis, Lym.



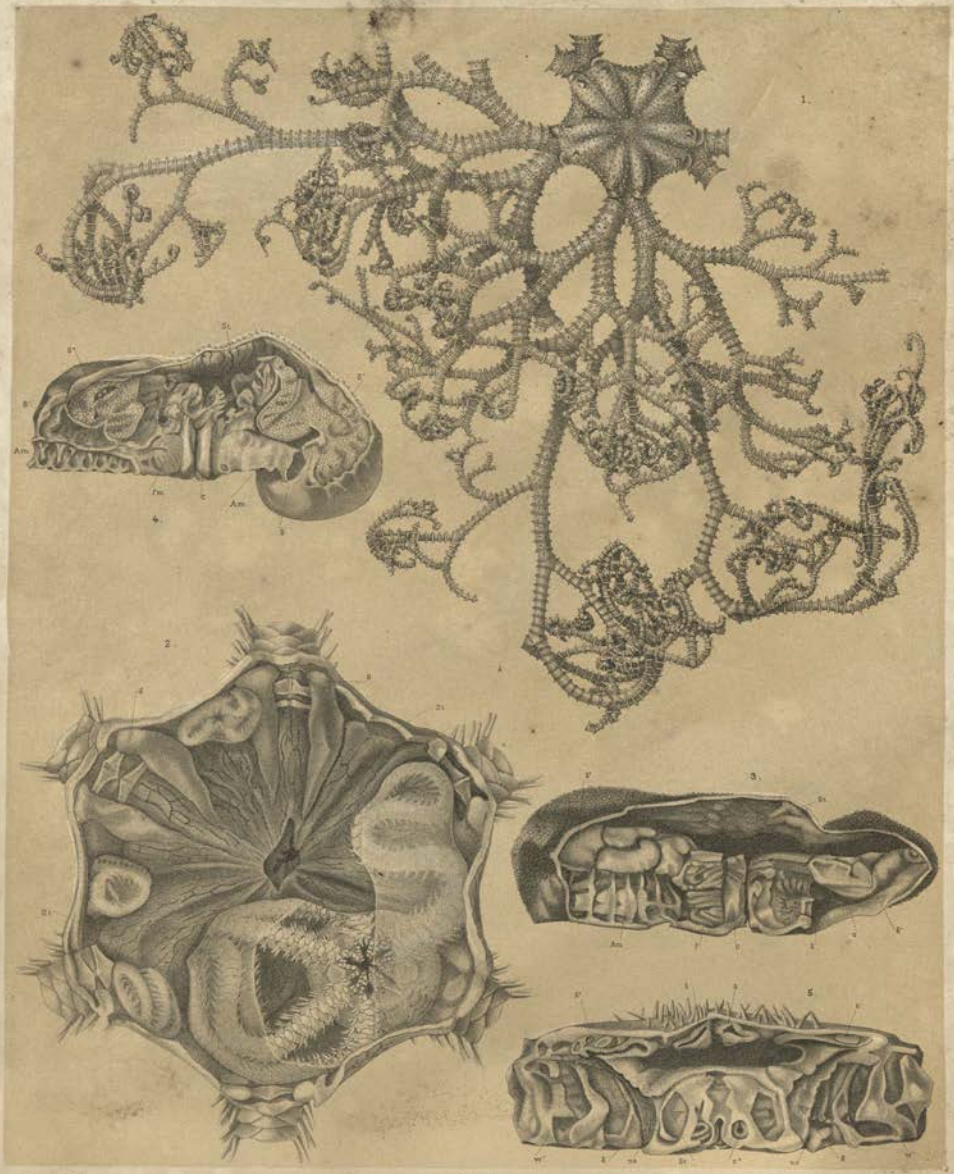
1-5. ASTROSCHEMA OLIGACTES. Lym. 6-9. OPHIOMYCES FRUCTOSUS. Lym. 10-12 ASTROCOMPHUS VALLATUS. Lym.

13-16. HEMIPHOLIS CORDIFERA. Lym.

1. Ophioglypha hexactis. E.A.Smith 2-5. Gorgonocephalus Pourtalesii. Lym. 6-9. Echyale aspera. Lmk.



1. Ophiocreas Œdipus. Lym. 2. Astrocnida Isidis. Lym. 3. Ophiura Elaps (?) Lym. 4. Ophiocamax. Sp. nov.
5. Amphiura lucasa. Lym. 6. Ophiopholis aculeata. Gray. 7-9. Ophiacantha vivipara. Ljn.



1. ASTROPHYTON EXIGUUM, Agass. 2. OPHIOGLYPHA HEXACTIS. EA Smith. 3. OPHIOCOMA SCOLOPENDRINA, Agass.

4. OPHIOTHRIX LONGIPEDA, Müller. 5. OPHIOCAMAX, sp. nov.

Eliz. H. Clarke del. nat. The Edinburgh Printing & Sr. Thomas Hutton

GORGONOCEPHALUS VERRUCOSUS.

THE

VOYAGE OF H.M.S. CHALLENGER.

ZOOLOGY.

REPORT on some points in the ANATOMY of the THYLACINE (*Thylacinus cynocephalus*), CUSCUS (*Phalangista maculata*), and PHASCOGALE (*Phascogale calura*), collected during the Voyage of H.M.S. Challenger in the years 1873–1876; with an account of the Comparative Anatomy of the Intrinsic Muscles and the Nerves of the MAMMALIAN PES. By D. J. CUNNINGHAM, M.D., F.R.S.E., Professor of Anatomy in the Royal College of Surgeons in Ireland.

IN March 1877 I received from Sir C. Wyville Thomson, for purposes of anatomical research, all the Marsupial animals brought home by the Challenger Expedition. The collection comprised the following specimens:—

Four	specimens	of the	*Phalangista vulpina.*
Three	„	„	*Dasyurus viverrinus.*
Two	„	„	*Thylacinus cynocephalus.*
One	„	„	*Phalangista maculata.*
One	„	„	*Phascogale calura.*

Of these I chose for special examination the *Thylacine*, the *Cuscus*, and the *Phascogale*. In this choice I was influenced by the fact that these three species are the least known, and represent types which differ widely from each other, both in physique and habits. The other specimens I merely used for purposes of comparison, and am not prepared, therefore, to give a detailed account of their anatomy even were this advisable.

Both specimens of *Thylacinus* were sent to the Challenger Expedition while at Sydney, by Sir Charles Du Cane, K.C.M.G., the then Governor of Tasmania. The one was a large male, the other a female very much smaller in size. The following were the measurements:—

Male.	Ft.	in.
From the tip of the nose along the back to the root of the tail, . .	3	3
Length of tail, ...	1	8½
Female.		
From the tip of the nose along the back to the root of the tail, . .	2	7
Length of tail, ...	1	4

The male had manifestly been received in a very putrid state, but its long immersion in strong spirit had considerably improved its condition. The female was in an admirable state of preservation, and it is consequently from it that the majority of the drawings have been taken and the description framed. A special interest is attached to the anatomy of this animal, from the very prevalent belief that the genus of which it is the sole member is rapidly becoming extinct. Thus Owen,[1] writing in 1842, speaks of it as a species "whose term of existence seems fast waning to its close."

The *Cuscus* was obtained in New Guinea, and was presented to Sir Wyville Thomson, while on a visit to Queensland, by Mr. Sheridan of Maryborough.

In my examination of the intrinsic muscles of the marsupial manus and pes, I was met by a somewhat puzzling multiplication of the elements. To explain this, and at the same time connect the condition with that found in other animals, I was induced to extend my inquiries upon this point into Mammalia generally. The results of this investigation I have incorporated with the present report.

Myology of the Anterior Limb.

Shoulder and upper arm.—Before entering upon a description of the muscles of the shoulder, it is necessary to refer to the condition of the clavicle. In the *Cuscus* and *Phascogale* this bone is well developed, and, stretching from the sternum to the scapula, has a distinct attachment to both. In the *Thylacinus*, on the other hand, the clavicle is exceedingly rudimentary. It is merely represented by a narrow curved rod of bone, about two inches in length, embedded in the substance of the cephalo-humeral muscle, and in no way attached to the acromion. To the sternum it is joined indirectly by an ill-defined fibrous band or raphe.

Trapezius.—This muscle has a similar origin in the three animals. It springs from the occipital crest, from the spinous processes of all the cervical vertebræ, and from the spines of the seven anterior dorsal vertebræ. From this extensive origin its fibres extend in the form of one unbroken muscular sheet, and converge towards the shoulder. Here the posterior and greater part of the muscle is inserted into the spine of the scapula (Pl. I. fig. 5, *tr.*), and the root of the acromion process, whilst the anterior portion sweeps over

[1] Transactions of the Geological Society, 1842, vol. vi., 2nd series on the *Phascolotherium*.

the head of the humerus, so as to clothe the humerus on its anterior and outer aspects, and is inserted differently in each animal. In the *Cuscus* a very few of these anterior fibres—those constituting the anterior free margin of the muscle—are attached to the clavicle. The remainder are continued downwards, and fuse with the acromial and clavicular portions of the deltoid. In the *Phascogale* the insertion of this part of the trapezius is precisely similar, with the exception that none of the fibres join the acromial deltoid—all enter the clavicular portion of that muscle. In the *Thylacine* the humeral division of the trapezius is more strongly marked than in either of the two preceding animals. In passing over the rudimentary clavicle, some of its deeper fibres mix with those of the other muscles attached to this bone, and it ends entirely in the clavicular deltoid (Pl. I. fig. 4, *tr.*).

According to Professor Macalister the humeral division of the trapezius in the Wombat is in no way attached to the clavicle, but, gliding over it, replaces the clavicular deltoid; in the Tasmanian Devil, on the other hand, no portion of the muscle reaches the humerus—all its fibres being inserted into the scapular spine, acromion process, and the outer fourth of the clavicle.[1] In the *Perameles* the anterior fibres of the trapezius are described by Professor Owen[2] as "being directly continued into the pectoralis major." Whilst the scapular or posterior portion of the trapezius therefore appears to be very constant in its insertion, the anterior or humeral part is subject to considerable variations.

Rhomboideus.—In none is this muscle divisible into its three constituent parts. In each of the three specimens it forms a continuous muscular layer, which arises for a varying extent from the occipital crest under cover of the trapezius and the cleido-occipital when this muscle exists, from all the cervical and from the two anterior dorsal spines. In the *Cuscus* and *Phascogale* the occipital origin is relatively wider than in the *Thylacine*. Those fibres which spring from the dorsal, and from the two or three cervical spines, are disposed in much coarser fasciculi than the fibres in the anterior part of the muscle, and they probably represent the rhomboideus proper. The entire muscle is inserted into the whole extent of the base of the scapula.

In the *Phascogale* the lower margin of the muscle, as it approaches the scapula, fuses with the upper border of the acromio-trachelien muscle, and in this manner it is inserted to a small extent into the root of the scapular spine.

Macalister[1] describes a more extensive origin of the rhomboideus in the Wombat. In this animal it extends back as far as the fourth or fifth dorsal spine. In the Tasmanian Devil, according to the same authority, it consists of two distinct portions, viz., a rhomboideus occipitalis and a rhomboideus proper composed of the amalgamated major and minor.

Acromio-trachelien (the omo-atlantic of Haughton and Macalister).—In the *Cuscus* and *Phascogale* this muscle is double; in the *Thylacine* it is single.

[1] Myology of the Wombat and Tasmanian Devil, Annals and Magazine of Natural History, vol. v.
[2] Comparative Anatomy and Physiology of Vertebrates.

In the *Cuscus* the acromio-trachelien consists of two distinct fleshy bands—a small superior band and a larger inferior band. These may appropriately be called the acromio-trachelien superior and acromio-trachelien inferior. The former arises by two slips from the transverse processes of the atlas and axis vertebræ, whilst the latter takes origin from the transverse process of the atlas alone. Narrow and rounded towards their origin they wind round the lower margin of the splenius, and then diverging from each other as they proceed backwards they expand into two thin muscular bands. Near the scapula they coalesce, and are inserted into the whole length of the scapular spine, and also into the posterior margin of the acromion process.

In the *Phascogale* the arrangement is very similar; still there are certain essential points of difference. Thus both fleshy bands arise from the atlas alone, they remain distinct throughout their entire extent, and, lastly, the acromio-trachelien superior, as it approaches the scapula, fuses by its upper margin with the rhomboideus.

In the *Thylacine* the single acromio-trachelien arises from the lower aspect of the transverse process of the atlas, and, expanding as it passes backwards, is inserted into the lower half of the scapular spine and into the posterior border of the acromion process (Pl. I. fig. 5, *a.t.*).

Cuvier and Laurillard (pl. clxxxviii.) figure a double acromio-trachelien in the *Macropus major*, the two parts of which are very distinct, and inserted at a considerable distance from each other.

Cleido-occipital.—This muscle is found in *Cuscus* and *Phascogale*, but it is absent in the *Thylacine*.

In the *Cuscus* (Pl. II. fig. 1, *c.o.*) it is a very narrow slip of muscle, and being closely applied to the upper margin of the cleido-mastoid, it is not at first apparent. Posteriorly it is attached to the sternal end of the clavicle, anteriorly it is inserted into the occipital ridge upon the same plane as the trapezius and sterno-mastoid.

In the *Phascogale* the cleido-occipital is a well-marked muscle, which is clearly mapped off from the cleido-mastoid throughout its whole length. Its attachments are the same as in the case of the *Cuscus*, but as it approaches the occiput it fuses with the anterior margin of the trapezius.

In the Wombat and Tasmanian Devil the cleido-occipital is absent; at least Macalister[1] makes no mention of it in either case. In Cuvier and Laurillard's plates it is figured in the *Didelphys cancrivora* (pl. clxxvi. fig. 1) and in the *Macropus minor* (pl. clxxxi. fig. 1), but not in the *Phalangista cavifrons* (pl. clxxix. fig. 1).

Cleido-mastoid.—In *Cuscus* and *Phascogale* this muscle arises from the sternal end of the clavicle, in close proximity to the origin of the cleido-occipital. As it proceeds forwards it sinks under cover of the sterno-mastoid to gain its insertion into the mastoid process.

[1] *Loc. cit.*, p. 3.

In the *Thylacine* the connections of the cleido-mastoid are very different. At the root of the neck it stands widely apart from its colleague the sterno-mastoid. Anteriorly it is attached to the mastoid process under cover of the sterno-mastoid. From this it is carried backwards towards the shoulder in the form of a narrow fleshy band. Reaching the rudimentary clavicle its fibres are partly inserted into the inner half of this bone, and partly continued into the clavicular deltoid (Pl. I. fig. 4, *c.m.*).

Latissimus dorsi.—This muscle has a shape very similar to that of the corresponding muscle in man. It arises from the spinous processes of all the dorsal vertebræ with the exception of the first and second, from the lumbar aponeurosis and by a single digitation from the last rib. From this wide origin it sweeps downwards and forwards so as to overlap the posterior angle of the scapula. In no case does it receive fasciculi from this bone. As it approaches the humerus it becomes much narrower, but, at the same time, what it loses in width it gains in thickness. In the *Cuscus* and *Phascogale* the insertion of the latissimus dorsi is identical; in the *Thylacine* it is somewhat different. In all it is more or less connected with that of the teres major.

In *Cuscus* (Pl. II. fig. 4, *l.d.*) and *Phascogale* the latissimus dorsi, as it approaches its insertion, divides into two parts. Of these the upper and smaller slip which corresponds with the anterior margin of the muscle passes behind the other part and joins the posterior margin of the teres major with which it is inserted. The posterior and main portion of the muscle gives off the dorsi-epitrochlear and then ends in a strong flat shining tendon. This proceeds outwards under cover of both heads of the biceps, and is inserted into the bottom of the broad shallow bicipital groove of the humerus. This attachment is separated by a wide interval from the insertion of the teres major, and abuts against that of the pectoralis major.

In the *Thylacine* the teres major and the latissimus dorsi have a common insertion into the humerus through the medium of a strong tendinous band, which arches backwards from the bottom of the bicipital groove. This band is twisted upon itself so that it presents a round, smooth, and cord-like posterior border. Into the lower half of this common tendon the teres major is inserted—a few of its fibres, however, obtaining a direct attachment to the humerus immediately below the lesser tuberosity; into the upper part of the tendon the latissimus dorsi is inserted.

Dorsi-epitrochlear.—This muscle is present in all, although relatively it is best developed in the *Phascogale*. It springs from the posterior margin of the latissimus dorsi a short distance from its insertion, and is carried downwards upon the inner aspect of the long head of the triceps. It is inserted in the *Cuscus* (Pl. II. fig. 4, *d.e.*) and *Phascogale* into the inner aspect of the tip of the olecranon process. In the *Thylacine* it joins the triceps near the elbow and is inserted with it.

Serratus magnus.—In the *Cuscus* (Pl. II. fig. 4, *s.m.*) only is there any indication of a division of this muscle into a cervical and a costal portion. In the *Phascogale* and

Thylacine it constitutes one unbroken muscular sheet. The cervical part is composed in all of five slips from the transverse processes of the five posterior cervical vertebræ. The costal origin differs in each case. In the *Cuscus* it is the most extensive, and consists of eight digitations from the eight anterior ribs; in the *Phascogale* it is formed by seven digitations, and in the *Thylacine* by six digitations. In each animal it is inserted into the entire length of the base of the scapula.

Subclavius.—In the *Cuscus* (Pl. II. fig. 4, *s.c.*) and *Phascogale* the subclavius presents the ordinary attachments. In both it is very strongly developed, and arises by a pointed tendinous origin from the cartilage of the first rib. Expanding in a fan-shaped manner, it is inserted into the outer two-thirds of the upper sharp margin of the clavicle. In neither case does the muscle extend beyond the outer end of the clavicle towards the acromion process or supraspinatus fascia.

In the *Thylacine* (Pl. I. fig. 5, *s.c.*) the connections of the subclavius are very different. It is present in the form of a sterno-scapular band, which takes origin from the cartilage of the first rib, and then proceeds outwards upon the superficial aspect of the axillary vessels and nerves. Reaching the rudimentary clavicle, it sinks under cover of this bone and its attached muscles, and sweeps over the tuberosities of the humerus like a strap. It now changes its direction, and is carried upwards upon the supraspinatus, and is finally inserted into the fascia covering that muscle. It has no direct attachment to the scapular spine or to the outer end of the clavicle.

According to Macalister,[1] the subclavius in the Wombat is inserted directly into the outer sixth of the clavicle, into the upper border of the acromion process, and into the scapular spine. Professor Rolleston's description of the same muscle in this animal is somewhat different.[2] He states that it is inserted into the outer end of the clavicle, and by means of the fascia covering the supraspinatus into the whole length of the spine of the scapula. In any case, from its having a clavicular attachment, the Wombat exhibits an intermediate condition between the *Cuscus* and *Phascogale* on the one hand and the *Thylacine* on the other.

Cuvier and Laurillard figure (pl. clxxvi. fig. 1, *h.h'*) a subclavius muscle in *Didelphys cancrivora*, which appears to have similar attachments to those of the corresponding muscle in the Wombat. In the *Macropus major* (pl. cxcv. fig. 1, *h*), in the *Macropus minor* (pl. clxxxi. fig. 1, *h*), and in the *Phalangista cavifrons* (pl. clxxix. fig. 3, *h*) the same authorities figure the subclavius as it is found in the *Cuscus* and *Phascogale*. In the Opossum Professor Haughton[3] states that the subclavius is inserted into "the under surface of the outer third of the clavicle and the front of the acromion."

I fully agree with Professor Macalister in his remark, that "we can scarcely regard the sterno-scapular as anything but a variety of the subclavius."

[1] *Loc. cit.*, p. 3.

[2] On the Homologies of Certain Muscles connected with the Shoulder-Joint, Trans. Linn Soc., vol. xxvi. p. 626

[3] On the Muscles of Marsupials, Proc. Roy. Irish Academy, vol. ix. p. 485.

Pectoral muscles.—These muscles present a very complicated arrangement. In the *Cuscus* there are four distinct factors, viz. :—

(1) A large superficial fan-shaped muscle,
(2) An anterior deep band of muscular fibres, } pectoralis major.
(3) A posterior deep muscle, probably the pectoralis minor.
(4) The pectoralis quartus.

The first two may be regarded as being constituent parts of the pectoralis major. The large superficial fan-shaped portion (Pl. II. figs. 1 and 4, p^1.) arises from the whole length of the sternum and ensiform cartilage. From this it passes outwards, and is inserted into the outer lip of the bicipital groove, where it coalesces slightly with the clavicular deltoid. The deep portion (Pl. II. figs. 1 and 4, p^2.) takes origin from the anterior third of the sternum, and throughout is quite separated from the preceding muscle. Stretching outwards and slightly forwards as a thick fleshy band, it is inserted into the external tuberosity, and a small portion of the external bicipital ridge of the humerus. The pectoralis minor (Pl. II. figs. 1 and 4, p^3.) springs from the posterior two-thirds of the body of the sternum, and also from one or two of the costal cartilages. From this it proceeds outwards and forwards, and sinking under cover of the small deep portion of the pectoralis major, it is inserted into the inner margin of the great tuberosity of the humerus, into the capsule of the shoulder-joint, and through the medium of a strong aponeurotic membrane into the tendon of the supraspinatus and the coracoid process. Its origin from the costal arches and its indirect insertion into the coracoid process seem to indicate that this muscle is the pectoralis minor. The pectoralis quartus (so-called by Professor Macalister) (Pl. II. figs. 1 and 4, p^4.) arises behind the ensiform cartilage from the linea alba, and from the fascia over the rectus abdominis, and extends forwards and outwards under cover of the superficial part of the great pectoral to the upper part of the pectoral ridge into which it is inserted. The humeral portion of the panniculus carnosus (Pl. II. fig. 1, *p.c.*) fuses with it at its insertion.

In the *Phascogale* the pectoral muscles are identical with those of the *Cuscus* with two exceptions, viz., (1) there is no deep muscle corresponding with the deep portion of the pectoralis major; (2) the pectoralis quartus is more strongly developed, and is more in the form of a fleshy band.

In the *Thylacine* the pectoral muscles consist of a small superficial muscle, a large deep muscle, and a very rudimentary pectoralis quartus.

The superficial muscle is the representative of the pectoralis major. It arises from that part of the sternum which lies in front of the junction of the second costal cartilage.

The deep muscle, which is the representative of the pectoralis minor, springs from the whole of the sternum behind the preceding muscle, and also from some of the posterior costal cartilages.

The pectoralis major is inserted into the pectoral ridge of the humerus, whilst the pectoralis minor finds attachment at a higher level into the great tuberosity of the humerus, and also into the tendon of the supraspinatus. The two muscles therefore cross each other as they pass towards their insertions.

The pectoralis quartus is composed of two minute fleshy slips which arise from the linea alba, and end by fusing with the under surface of the pectoralis major.

A study of Cuvier and Laurillard's plates shows that the *Phalangista cavifrons* (pl. clxxix. fig. 2, $j, j^1, j^2 + j$), the *Macropus minor* (pl. clxxxi. fig. 1, $j, j^1, j^2, j +$), and the *Macropus major* (pls. cxciii. and cxciv.) agree in almost every respect with the *Cuscus* in the arrangement of the pectoral muscles. In the Wombat Professor Macalister[1] describes the same four pectoral muscles; in the Tasmanian Devil he states that the pectoralis major is not segmented (*i.e.*, there is no deep portion), and in this respect, therefore, it corresponds with the *Phascogale*. In both these animals, however, the great pectoral muscle receives fibres of origin from the clavicle.

There is a diversity of opinion regarding the character of the pectoralis quartus. Owen[2] looks upon it as "a dismemberment of the pectoralis major." Humphrey and Macalister[1] believe that it is in an "intermediate piece of the great superficial external muscular sheet between the pectoralis major and latissimus dorsi." Its close connection in many cases with the panniculus carnosus would almost seem to indicate that it is merely a portion of this muscle. In the *Cuscus*, indeed, it appeared to be simply the thickened lower margin of the panniculus, the connection between them was so intimate.

Scapular muscles.—In all the three specimens the supraspinatus is much more bulky than the infraspinatus. This is most marked in the *Phascogale* in which it is fully three times as large. In the *Thylacine* it is nearly twice as large (Pl. I. figs. 4 and 5, *s.s.*); in the *Cuscus* the disparity in size is not quite so great.

A teres minor, distinct from the infraspinatus, is present in the *Thylacine* (Pl. I. fig. 4, $t.m^2$.) and *Cuscus*. In both cases this muscle is supplied by a small twig from the circumflex nerve. It arises from a small portion of the axillary border of the scapula close to the glenoid cavity, and is inserted into the humerus upon its outer and posterior aspect immediately below the great tuberosity. In the *Phascogale* the teres minor is absent, and no twigs from the circumflex nerve could be traced to the portion of the infraspinatus which might be supposed to represent it.

The teres major is well developed in each of the three specimens. It has a very slight origin from the dorsum of the scapula at the posterior angle of the bone. Its main origin is from the axillary border of the scapula in its upper two-thirds. Here it is intimately connected with the posterior border of the subscapularis by means of an intermuscular septum, which gives fibres to both. In the *Cuscus* (Pl. II. fig. 4, *t.m.*) and *Phascogale* it receives a slip from the latissimus dorsi, and is then inserted into the inner

[1] *Loc. cit.*, p. 3. [2] Anatomy of Vertebrates, vol. iii. p. 12.

lip of the bicipital groove of the humerus. In *Thylacine* it is inserted in common with the latissimus dorsi through the medium of a fibrous arch (*vide* p. 5).

The subscapularis is well marked in all, and presents the usual attachments.

According to Meckel the infraspinatus is smaller than the supraspinatus in the Marsupialia generally. The accuracy of this observation is shown by Professor Macalister,[1] who gives the definite information that "the supraspinatus is larger in the Wombat, *Phalanger, Perameles, Sarcophilus,* and the Opossum; in the Giant Kangaroo they are about equal, while in Bennett's Kangaroo the infraspinatus is the larger."

Cuvier and Laurillard do not figure a teres minor in the *Phalangista cavifrons* (pl. clxxviii. fig. 1), but they represent a very strong teres minor in the Giant Kangaroo, (pls. clxxxvii. and clxxxviii.). This hardly agrees with Professor Macalister's description.[1] This author states that it is not separable from the infraspinatus in the *Macropus giganteus, Phalangista vulpina, Perameles lagotis,* and *Didelphys virginiana;* in the Wallaby, however, it is distinct, and in the Wombat and Tasmanian Devil it is represented by "a fascial band."

Deltoid.—In the *Cuscus* the scapular and clavicular portions (Pl. II. fig. 4, *c.d.*) of this muscle are distinct above, and separated from each other by a considerable interval. The scapular part is much the larger of the two; it arises from the acromion process, from the spine of the scapula in its entire length, and from the fascia covering the infraspinatus muscle. As the acromial part proceeds downwards, it is joined on its superficial surface by those fibres of the trapezius which in man are inserted into the acromion process. The clavicular portion of the muscle springs from the middle third of the clavicle, and it receives those fibres of the trapezius which in man are attached to the clavicle. Thus reinforced by trapezial fibres the two portions of the deltoid converge as they pass downwards towards a salient ridge jutting out from the antero-external aspect of the shaft of the humerus, at the junction of its upper and middle thirds. The scapular deltoid is inserted into the outer surface of this ridge, whilst the clavicular deltoid is fixed to its summit, where it is fused to a certain extent with the insertion of the pectoralis major.

In *Phascogale* the deltoid is broken up into three distinct factors—clavicular, acromial, and spinal—quite separate from each other except at their insertion. This triple constitution of the muscle is due to the acromial fibres passing down as a narrow band, apart from the fibres which take origin from the spine of the scapula. The humeral portion of the trapezius joins the clavicular deltoid alone, and has no connection whatever with the acromial part of the muscle. The insertion is the same as in *Cuscus;* the ridge in the shaft of the humerus, however, is not so strongly marked.

In *Thylacinus* (Pl. I. figs. 4 and 5) the deltoid is in two parts,—scapular (*s.d.*) and clavicular (*c.d.*),—and these are separate from each other both at their origin and at their insertion. The scapular deltoid is much the larger of the two, and it has a similar

[1] *Loc. cit.*, p. 3.

origin to the same muscle in *Cuscus*. It is inserted into the outer aspect of the shaft of the humerus about an inch below the great tuberosity, and at a higher level than the clavicular deltoid. It receives no fibres from the trapezius. The clavicular deltoid is composed of fibres derived from three distinct sources. In great part it is formed by fibres which come from the trapezius and the cleido-mastoid muscle, but it also obtains some which spring directly from the lower border of the rudimentary clavicle. Thus constituted it is inserted into a ridge upon the antero-external aspect of the shaft of the humerus about its middle, where it is partially fused with the insertion of the pectoralis major.

According to Macalister[1] the deltoid in the Wombat is double, whilst in the Tasmanian Devil it is triple as in the *Phascogale*. The same authority states that the muscle is "undivided" in the Giant Kangaroo, in *Macropus bennettii*, the *Phalanger*, and the Virginian Opossum. In the Koala[2] it is composed of two parts—clavicular and scapular. The above facts might lead us to question the general applicability of the assertion made by Owen in his great work upon the Comparative Anatomy of Vertebrates that "in claviculate Marsupials the deltoid . . . consists of three fasciculi."

Cephalo-humeral muscle.—We are now in a position to understand the constitution of the composite muscle to which this name is applied. In the *Cuscus* it consists of that portion of the trapezius which, in man, is inserted into the acromion and clavicle united with the acromial and clavicular parts of the deltoid. In the *Thylacine* and *Phascogale*, on the other hand, the acromial deltoid is not a constituent. In the former (Pl. I. fig. 4, *c.h.*) it is composed of the cleido-mastoid, the anterior fibres of the trapezius, and the clavicular deltoid, in the latter it is formed by the anterior fibres of the trapezius and the clavicular deltoid.

Coraco-brachialis.—Professor John Wood has taught us, in his well-known paper upon Muscular Variations,[3] to look upon the typical coraco-brachialis as being a muscle with a triple constitution. The animals in question afford a beautiful example of this. In each the coraco-brachialis brevis is present, and in *Thylacinus* it constitutes the sole representative of the muscle, which in this respect therefore resembles the carnivora. It springs from the coracoid processes, in common with the coracoid portion of the biceps. and spreading out in a fan-shaped manner, passes downwards over the insertion of the subscapularis to find attachment to the shaft of the humerus immediately above the insertion of the teres major. It is a short thick fleshy muscle.

In addition to the short muscle, the *Phascogale* possesses a coraco-brachialis medius—a very slender fasciculus which is inserted into the middle of the inner aspect of the shaft of the humerus, whilst in the *Cuscus* we find a coraco-brachialis longus (Pl. II. fig. 4, *c.b.l.*) inserted into the bridge of bone which walls in the supra-condyloid foramen of the humerus.

[1] *Loc. cit.*, p. 3. [2] Young, Muscular Anatomy of Koala, Journal of Anatomy and Physiology, vol. xvi.
[3] Journal of Anatomy and Physiology, vol. i.

In Cuvier and Laurillard's plates both the short and long slips are figured in the *Phalanger* (*Phalangista cavifrons*) (pl. clxxix. fig. 4, *q*); whilst in the Virginian Opossum (pl. clxxv. fig. 4, *q*) and the Giant Kangaroo the short muscle is alone represented. In the Wombat, *Sarcophilus*, and *Macropus ruficollis*, Professor Macalister[1] describes only the short variety of the muscle, but in the Koala Mr. Young[2] states that the three muscles are present, although the coraco-brachialis medius and coraco-brachialis longus are fused.

Biceps.—In the *Thylacine* the biceps springs by two tendons from the upper margin of the glenoid cavity and from the coracoid process. These after a short independent course unite to form a powerful flattened tendinous band from which the muscular fibres issue. At first the fleshy belly is undivided, but about the junction of the upper with the middle thirds of the upper arm it splits into a superficial and a deep portion (the coraco-radial and the gleno-ulnar muscles). The former is inserted into the radial tubercle, whilst the latter is fixed along with the brachialis anticus into the coronoid process of the ulna.

In the *Cuscus* (Pl. II. fig. 4, *b.*) and *Phascogale* the two portions of the biceps show similar attachments, but the fleshy bellies are distinct throughout, and there is merely a partial fusion of the tendons of origin. If the muscles be forcibly torn asunder in an upward direction it will then be seen that, whilst the gleno-ulnar arises from the upper margin of the glenoid cavity alone, the coraco-radial has a double origin, *i.e.*, both a coracoid and a glenoid origin; it therefore presents the same attachments as the entire muscle in man.

Brachialis anticus.—In the *Thylacinus* (Pl. I. figs. 4 and 5, *b.a.*) the brachialis anticus has a linear origin from the posterior aspect of the shaft of the humerus under cover of the outer head of the triceps, but separated from it by a well-marked external intermuscular septum. The muscle winds round the bone so as to clothe its outer surface and gain the anterior aspect of the limb at the elbow-joint; here it is inserted behind the gleno-ulnar into the coronoid process of the ulna.

In the *Cuscus* and *Phascogale* the brachialis anticus differs from that of the *Thylacine* in deriving fibres of origin from the outer aspect of the humeral shaft, and also in having a closer connection with the external intermuscular septum.

Triceps.—In Marsupials this muscle is usually very strongly developed, and the three animals under consideration offer in this respect no exception to the general rule. In *Thylacinus*, indeed, it seems to attain a maximum development. In all the three heads are easily separable.

In the *Thylacine* (Pl. I. figs. 4 and 5, tr^1. tr^2.) the scapular head has a very extensive and at the same time a somewhat peculiar origin. It springs from nearly the whole length of the axillary border of the scapula and by two distinct sets of fibres, viz., (1) a series which have a tendinous origin from the bone close to the glenoid cavity, and which pass down to constitute the long head of the triceps as it is usually observed. (2) A

[1] Annals and Magazine of Natural History, vol. v. [2] Journal of Anatomy and Physiology, vol. xvi.

series of short fleshy fasciculi which arise from the scapular border above this, and which curve downwards and forwards in the form of a thin fleshy layer to blend with the fibres of the scapular head in its upper third. The external head takes origin from the posterior aspect of the humerus in its upper half, and is here blended with the brachialis anticus through the intervention of the external intermuscular septum. The inner head arises from the inner and posterior aspect of the humerus in all its length. It is pierced by the musculo-spiral nerve, which splits it into two distinct portions. The three heads of the triceps do not fuse until they reach the olecranon, into which the muscle has the usual insertion.

The *Cuscus* and *Phascogale* differ from the *Thylacine* in the following points:—(1) The long head does not spring from more than one-third of the scapular border, and all the fibres are derived from the one tendon of origin; (2) the inner head is weakly developed, and does not extend upwards upon the humerus beyond the insertion of the teres major; moreover, it is not pierced by the musculo-spiral nerve; (3) the three heads blend higher up the limb than in the case of the *Thylacine*. The triceps in *Cuscus* and *Phascogale* resemble very closely the triceps of man.

Macalister[1] states that in Marsupials "the lateral heads of the triceps are united into one large humeral muscle, inseparable from each other." I did not find this to be the case in the three animals in question.

Anconeus externus.—In the *Thylacine* the anconeus externus can hardly be said to exist. It is merely represented by a few of the lower fibres of the inner head of the triceps which are inserted upon the outer surface of the upper part of the olecranon. In the *Cuscus* (Pl. II. fig. 5, *a.e.*) it is largely developed, but inseparably united with the triceps. Springing from the back of the external condyle of the humerus, it is inserted into the outer surface of the olecranon and into the shaft of the ulna in its upper half. In the *Phascogale* the anconeus externus is almost identical with the same muscle in the *Cuscus*, but it is not so well marked, and does not extend so far down the shaft of the ulna. This muscle varies very greatly in its development in the different members of Marsupial group.

Anconeus internus (*Epitrochleo-anconeus*).—This little muscle is present in each of the three animals. It presents the usual attachments, viz., on the one hand, to the back of the internal condyle of the humerus, and on the other, to the inner side of the tip of the olecranon process. Its lower border is in opposition with a fibrous cord which bridges across the hollow between the condyle and the olecranon, and which gives origin to the fibres of flexor carpi ulnaris. In the *Cuscus* (Pl. II. fig. 4, *a.i.*) the anconeus internus is firmly united to the upper border of this cord, so that the two muscles are as it were merely separated by a fibrous raphe. In all cases the ulnar nerve passes under cover of the anconeus internus, and gives to it its nerve-supply.

[1] Annals and Magazine of Natural History, vol. v.

The anconeus internus is very generally present throughout the Marsupialia. Mr. Galton figures it in the Wombat;[1] Gruber in the *Dasyurus viverrinus*;[2] Cuvier and Laurillard in the Giant Kangaroo;[3] whilst it is described both by Macalister[4] and Young[5] in the Koala, and by the former author in the Tasmanian Devil.[6]

Forearm.

In the *Thylacinus* we find the following muscles upon the extensor aspect of the forearm:—

Superficial Muscles.

1. Supinator longus.
2. Extensor carpi radialis longior.
3. Extensor carpi radialis brevior.
4. Extensor communis digitorum.
5. Extensor digitorum secundus.
6. Extensor carpi ulnaris.

Deep Muscles.

1. Extensor ossis metacarpi pollicis.
2. Extensor secundi internodii pollicis.
3. Supinator brevis.

In the *Cuscus* the same muscles are found on the extensor aspect of the forearm as in *Thylacinus*.

In *Phascogale* the extensor carpi radialis longior and brevior are represented by a single muscle, whilst the extensor carpi ulnaris is split up into two factors. The deep muscles are the same as in *Thylacinus*.

Supinator longus.—In the *Thylacine* this muscle is very feebly developed. It consists of a narrow fleshy band (Pl. I. fig. 5, *s.l.*) which springs from the upper part of the external supracondyloid ridge of the humerus. The delicate thread-like tendon in which it ends passes under cover of the extensor ossis metacarpi pollicis, and is inserted in great part into the posterior annular ligament, but also slightly into the styloid process of the radius.

[1] Note on the Epitrochleo-anconeus or anconeus sextus (Gruber), Jour. of Anat. and Phys., vol. ix., pl. ii. fig. 3.

[2] Ueber den Musculus Epitrochleo-anconeus des Menschen und der Säugethiere, Mém. de l'Acad. Imp. des Sci. de St. Pétersbourg, tom. x., No. 5, 7th series.

[3] Pl. clxv. fig. 1, *n*.

[4] On the Muscular Anatomy of the Koala, Annals and Magazine of Natural History, vol. x., 4th series, p. 130.

[5] On the Muscular Anatomy of Koala, Jour. Anat. and Phys., vol. xvi.

[6] Further Obervations on the Myology of *Sarcophilus ursinus*, Annals and Magazine of Natural History, vol. x., 4th series, p. 19.

In the *Cuscus* (Pl. II. fig. 5, *s.l.*) and *Phascogale* the supinator longus is a muscle of great size, relatively much larger than the same muscle in man. It springs from the upper two-thirds of the external supracondyloid ridge of the humerus. Its tendon proceeds in a groove upon the dorsal aspect of the lower end of the radius, under cover of the posterior annular ligament to the scaphoid bone, into the outer aspect of which it is inserted.

Macalister[1] mentions that the supinator longus is absent in the Tasmanian Devil; with this single exception it appears to be almost universally present in the Marsupialia, and in the case of the Koala it attains a very great magnitude.[2]

Radial extensors.—The fleshy bellies of the extensor carpi radialis longior and extensor carpi radialis brevior are completely amalgamated in the *Phascogale;* the tendons, however, are separate. This also was the case in the female *Thylacine*, but in the large male *Thylacine* (Pl. I. fig. 5, *c.l.* and *c.b.*) and in the *Cuscus* the two muscles were separate throughout their entire extent.

In the *Thylacine* and *Phascogale* the radial extensors arise from the external supracondyloid ridge of the humerus below the supinator longus, and they are respectively inserted into base of the second and third metacarpal bone on its dorsal aspect.

The extensor carpi radialis brevior in the *Cuscus* (Pl. II. fig. 5, *c.b.*) is a very large and powerful muscle, and its origin is somewhat complicated. It may be said to arise by three distinct heads—(1) from the upper part of the external condyle of the humerus (*c.b*^{1}.); (2) from the tendinous expansion on the surface of the supinator brevis (*c.b*^{2}.); (3) from the posterior border of the radius below the supinator brevis (*c.b*^{3}.). These three slips of origin unite to form the muscle, which is inserted as usual into the radial border of the shaft of the metacarpal bone of the medius a short distance beyond the base.

The extensor carpi radialis longior in the *Cuscus* (*c.l.*) presents the ordinary origin, from the lower third of the external supracondyloid ridge of the humerus, and it is inserted into the radial border of the shaft of the metacarpal bone of the index about its middle.

As a general rule, in the Marsupials the radial extensors are amalgamated, and even in those cases where they are separate they exhibit, as in the *Thylacine*, a tendency to fusion. Thus Young[2] states that in the three specimens of Koala which he examined one possessed a single radial extensor, whilst in the other two they were "separate and distinct." Again, Meckel,[2] in his work upon Comparative Anatomy, states that in the Opossum there are two radial extensors, whilst Macalister[3] describes only one. The peculiar triple origin of the extensor carpi radialis brevior which is noticed in the *Cuscus* has not been observed (so far as I am aware) in any other Marsupial.

Extensor communis digitorum.—In all three animals this is a comparatively small muscle. It springs from the outer aspect of the external condyle.

[1] Ann. and Mag. of Nat. Hist., vol. x., 4th series.
[2] Young, Jour. Anat. and Phys., vol. xvi.
[3] Annals and Magazine of Natural History, vol. v.

In the *Thylacine* (Pl. I. fig. 5, *c.d.*) the fleshy belly divides high in the forearm into three slips, from which three tendons issue. On the dorsum of the manus each tendon splits into two, and each part is inserted into the dorsal expansion on the first phalanx of the various digits; thus the first tendon (enumerating them from the radial side), by means of its two slips, goes to the index and medius, the second to the medius and annularis, and the third to the annularis and minimus. In this manner, therefore, the medius and annularis each receive two tendinous slips from the common extensor, whilst the index and minimus only obtain one.

In *Cuscus* (Pl. II. fig. 5, *c.d.*) and *Phascogale* the common extensor gives off four tendons. On the dorsum of the manus these communicate freely with each other, and go one to each of the four ulnar digits.

In the Koala Young[1] states that the common extensor gives a tendon to each of the five digits. This must be regarded as exceptional, because in the great majority of Marsupials its insertion is limited to the four inner digits.

Extensor digitorum secundus (Pls. I. and II. fig. 5, *r.l.*).—This muscle is undoubtedly the representative of the extensor mimimi digiti in man. It is essentially the same in each of the three animals. Arising from the external condyle of the humerus its tendon splits into two parts on the dorsum of the manus, and these go to be inserted into the dorsal expansions on the back of the annular and little digits.

Macalister[2] gives some interesting information regarding this muscle. In the Wombat, Opossum, and *Phalanger* it supplies tendons to the annular and little digits; in the Tasmanian Devil, Bennett's Kangaroo, and the Giant Kangaroo to the medius, annularis, and minimus.

Extensor carpi ulnaris.—In the large male *Thylacinus* (Pl. I. fig. 5, *c.u.* and *m.u.*), and in the *Phascogale* this muscle was split up into two distinct factors, which are inserted respectively into the unciform bone, and the ulnar face of the base of the fifth metacarpal. In the female *Thylacine* and in *Cuscus* (Pl. II. fig. 5, *c.u.*) there was a a single ulnar extensor muscle inserted into the metacarpal of the minimus.

Extensor ossis metacarpi pollicis.—In the *Cuscus* this muscle has a very extensive origin from the extensor surfaces of both bones of the forearm in their upper two-thirds, and from a corresponding portion of the interosseous membrane. It divides into two fleshy slips, which emerge in the interval between the common extensor and the short radial extensor, and end in tendons (Pl. II. fig. 5, *c.r.* and *m.r.*) which wind round the radial border of the forearm to be inserted into the trapezium, and into the base of the metacarpal bone of the pollex respectively.

In the *Thylacine* (Pl. I. fig. 5, *c.r.* and *m.r.*) the two portions of the muscle are separable throughout their whole extent. That which is inserted into the metacarpal bone arises from the middle third of the radius, whilst that portion which goes to the

[1] Jour. Anat. and Phys., vol. xvi.

[2] Annals and Magazine of Natural History, vol. v.

trapezium springs from the lower half of the ulna, the adjacent part of the interosseous membrane, and very slightly from the radius.

In the *Phascogale* the muscle is very similar to the corresponding muscle in the *Cuscus*, but it has not so wide an origin.

It is very evident that this muscle in the Marsupials is a compound of the extensor ossis metacarpi, and the extensor primi internodii pollicis of man.

Extensor secundi internodii pollicis.—In the *Thylacine*, and *Phascogale* this muscle (which is undoubtedly the homologue of the muscle bearing the same name in man) sends tendons to three digits, viz., the pollex, index, and medius; in *Cuscus* it is split up into two distinct and separate muscles—one connected with the pollex alone, and the other with the medius.

In the *Thylacine* (Pl. I. fig. 5, *d.e.*) it springs from the radial side of the olecranon, and from the upper third of the posterior border of the ulna. In *Phascogale* the origin is similar, with this exception, that it has a more extensive attachment to the posterior border of the ulna. In both it is a thin band-like muscle, which proceeds downwards under cover of the ulnar extensors, and the extensor digitorum secundus to end in a single tendon. On the dorsum of the hand this tendon splits into three parts, which go to the three radial digits.

In the *Cuscus* (Pl. II. fig. 5, *e.p.*) the extensor secundi internodii pollicis arises by two distinct heads, viz., (1) from the radial surface of the olecranon and the posterior border of the shaft of the ulna in its upper third (*e.p*^{2}.); (2) from the radial border of the ulna in its middle third (*e.p*^{1}.). The anconeus externus extends downwards upon the ulna between these two heads (Pl. II. fig. 5, *a.e.*). Below the level of the anconeus the two slips of origin unite, and the tendon which issues from the fleshy belly goes to the second phalanx of the pollex.

The extensor medii (Pl. II. fig. 5, *e.m.*) in the *Cuscus* is a very delicate slip which springs from the middle third of the posterior border of the shaft of the ulna. It is inserted by a delicate tendon into the dorsal extensor expansion of the medius.

The extensor secundi internodii pollicis appears to be present in the majority of Marsupials. Thus Macalister describes it in the Wombat, Tasmanian Devil,[1] and Koala,[2] and Meckel speaks of it in the Opossum.[3]

Supinator brevis.—This muscle is feebly developed in all the three animals. In the *Cuscus*, in which it is best marked, it is inserted into rather less than the upper fifth of the anterior and inner surface of the shaft of the radius.

Posterior annular ligament.—This ligament forms five compartments on the back of the wrist in *Thylacinus* (Pl. I. fig. 5, *an.l.*) for the passage of the extensor tendons.

[1] Ann. and Mag. of Nat. Hist., vol. v., 4th series, p. 164.
[2] *Ibid.*, vol. x., 4th series, p. 131.
[3] Anat. Comp., vol. v. p. 329.

These are from the radial to the ulnar aspect of the limb—(1) on the radial border of the lower end of the radius for the tendons of the extensor ossis metacarpi pollicis; (2) on the dorsal aspect of the radius for the two tendons of the radial extensors; (3) in the nterval between the two bones of the forearm for the tendons of the extensor communis digitorum, and the tendon of the extensor secundi internodii pollicis; (4) on the dorsal aspect of the lower end of the ulna for the tendon of the extensor minimi digiti or extensor secundus digitorum; (5) on the ulnar aspect of the ulna for the tendon of the extensor carpi ulnaris.

In the *Cuscus* the posterior annular ligament presents seven compartments—(1) on the radial aspect of the wrist for the two tendons of the extensor ossis metacarpi pollicis; (2) on the dorsum of the radius for the supinator longus; (3) on the dorsum of the radius for the tendons of the two radial extensors; (4) on the dorsum of the radius for the extensor secundi internodii pollicis; (5) in the interval between the radius and ulna for the tendons of the common extensor and the extensor medii; (6) on the dorsum of the lower end of the ulna for the extensor minimi digiti; (7) between the styloid process and the lower end of the ulna for the extensor carpi ulnaris.

Turning now to the flexor aspect of the forearm, we find the following muscles:—

1. Pronator radii teres.
2. Flexor carpi radialis.
3. Palmaris longus.
4. Flexor carpi ulnaris.
5. Flexores digitorum.
6. Pronator quadratus.

Pronator radii teres.—The coronoid head of this muscle is absent in all. In *Cuscus* and *Phascogale* the muscle is very strongly developed; indeed, in the former it is inserted into the greater part of the radial margin of the shaft of the radius, viz., from the supinator brevis above to the root of the styloid process below. In *Thylacine* it is attached to the middle third of the external border of the radius.

Flexor carpi radialis.—This muscle is well marked in each of the three animals, and arises, in common with the great flexor muscle of the digits, from the internal condyle of the humerus. In *Cuscus* its tendon divides into two slips, and these are inserted one into the palmar aspect of the base of the second metacarpal, and the other into the palmar aspect of the base of the third metacarpal bone; in *Thylacine* it is inserted partly into the trapezium and partly into the base of the metacarpal bone of the pollex; and in *Phascogale* it is inserted into the trapezium alone.

The insertion of this muscle in Marsupials is somewhat variable. In the Wombat, *Phalanger*, Opossum, and Bandicoot it is inserted into the base of the second metacarpal;[1] into the metacarpal bone of the pollex[2] in Bennett's Kangaroo; and into the base of the middle metacarpal in the Koala.[3]

[1] Macalister, Ann. and Mag. of Nat. Hist., vol. v., 4th ser., p. 162.
[2] Haughton, Proc. Roy. Irish Acad., 1866, p. 479.
[3] Young, Jour. Anat. and Phys., vol. xvi. p. 230.

Palmaris longus.—In the *Thylacine* this muscle has very little direct attachment to the internal condyle of the humerus. It springs from the superficial aspect of the great flexor muscle of the digits, and ends in a powerful tendon which penetrates into the midst of the palmar pad. Here it breaks up into four strong slips which go to join the flexor sheathes of the four ulnar digits. In *Phascogale* the palmaris longus is arranged upon a similar plan, but in the palm it spreads out into a distinct palmar fascia.

In *Cuscus* there are three small muscular slips representing the palmaris longus, viz., (1) a very delicate fasciculus which springs directly from the internal condyle of the humerus; (2) a larger slip which arises in common with the great flexor of the digits; (3) and a deeper portion which issues from the superficial aspect of the flexor of the fingers. They all proceed to join the palmar fascia.

Flexor carpi ulnaris.—This muscle has a similar disposition in each of the three animals. It is a broad thin band which gradually tapers towards the point from which the tendon issues. As is customary in the majority of Marsupials it arises by two pointed processes—one from the internal condyle of the humerus, and the other from the olecranon process. Between these points it derives fibres from a strong fibrous arch which bridges across the interval between those bony prominences. In the *Thylacine* and *Phascogale* the lower border of the anconeus internus is in close apposition with this fibrous arch; in the *Cuscus* it is inseparably united with it. The ulnar nerve enters the forearm by passing downwards under cover of the anconeus internus and the fibrous arch in question. In all the three animals the flexor carpi ulnaris is inserted into the pisiform bone.

Flexores digitorum.—The flexor sublimis, the flexor profundus, and the flexor longus pollicis are in great part amalgamated in all the animals under consideration.

In *Cuscus* the great flexor mass arises in three parts, which in all probability represent the three factors which enter into its constitution. These may be termed (1) the radial, (2) the ulnar, and (3) the condylar.

The condylar portion is intermediate and superficial, and is probably the representative of the flexor sublimis. It arises from the internal condyle of the humerus. The radial portion springs from the anterior surface of the radius from the tubercle above to about the middle of the bone below. It lies under cover of the large pronatorradii teres, and represents the flexor longus pollicis. The ulnar subdivision takes origin from the ulnar surface of the olecranon under cover of the anconeus internus, and from the posterior border and ulnar surface of the shaft of the ulna in its upper half, under cover of the flexor carpi ulnaris. This portion apparently represents the flexor profundus.

The three subdivisions of the muscle thus derived unite to form a thick muscular mass, from the superficial aspect of which four minute and delicate fleshy slips issue. Each of these ends in a thread-like tendon, and they together constitute a flexor sublimis. The mass of the muscle now gives place to a rope-like tendon which is scooped out superficially

into a distinct longitudinal groove, and in this groove are lodged the four fleshy bellies and thread-like tendons of the flexor sublimis. This is the condition of affairs as low down as the lower border of the anterior annular ligament, but here the thick rope-like tendon divides into five parts, and these diverge—one going to each of the five digits. The minute tendons of the sublimis also separate and pass one to each of the four ulnar digits. On the fingers the tendons are arranged in the usual manner.

In the *Thylacine* and *Phascogale* the arrangement of the flexor muscle is very similar. In the former, however, it is to be noted that the condylar portion of the muscle is very much the largest of the three divisions, and also that the ulnar part springs from both bones of the forearm and from the interosseus membrane between them. Further, the four minute tendons of the sublimis have no fleshy bellies, but arise directly from the superficial surface of the rope-like tendon of the profundus.

The nerve supply of the great flexor muscle shows how thoroughly the fibres of the flexor sublimis and flexor profundus are commingled. Both the ulnar and median nerves send twigs to the condylar and ulnar portions of the muscle, whereas the radial portion derives its nerve-filaments from the median alone.

The lumbrical muscles are four in number in each of the three animals. They spring from the four ulnar tendons of the flexor profundus, and are inserted one into each of the four ulnar digits. In *Thylacinus* and *Phascogale* they are very minute and insignificant, but in *Cuscus* they are powerfully developed, and expand greatly at their insertions.

Pronator quadratus.—In *Thylacinus* this muscle lies over the lower fourth of the two bones of the forearm; in *Cuscus* and *Phascogale* it covers fully a third of the bones. Compared with other Marsupials, therefore, it may be considered to be poorly developed in these three animals.

Intrinsic Muscles of the Hand.

By the term intrinsic, as applied to the muscles of the hand, I mean those muscles which remain after the removal of the flexor and extensor tendons. It does not include the lumbricales.

In the *Thylacine*, *Cuscus*, and *Phascogale* the intrinsic muscles of the manus may be considered to consist of three groups, viz., (*a*) a palmar; (*b*) an intermediate; and (*c*) a dorsal, according to the plane which they occupy, as we dissect from the palmar to the dorsal aspect of the hand. But further, these three groups have each their own distinctive action upon the fingers with which they are connected, and thus this classification of them is founded, not only upon anatomical but also upon physiological grounds. The palmar group is composed of the adductors of the fingers. The dorsal group consists of the four dorsal interossei, and also of the abductor pollicis and abductor minimi digiti. The two

latter do not, strictly speaking, lie upon a plane posterior to the palmar and intermediate muscles. They are palmar in their orgin, but they cross the margins of the hand obliquely, and they are clearly dorsal in their insertion. Their palmar orgin is for the purpose of giving them a more powerful action upon their respective fingers. But it is their abducting action more than the position which they occupy in the hand which indicates their association with the dorsal interossei. The intermediate group of muscles is a series of paired muscles, which includes the flexor brevis pollicis and the flexor brevis minimi digiti. They are placed upon the palmar aspect of each metacarpal bone, and they act chiefly as flexors of the fingers at the metacarpo-phalangeal joints.

The manus of each of the three animals presents distinctive peculiarities in the arrangement of these muscles, and it is therefore necessary to study each in turn. As the *Phascogale* exhibits the simplest arrangement, we will begin with it.

Phascogale.

The hand of this animal is very minute. It measures only one inch in length and a quarter of an inch in breadth, and consequently the intrinsic muscles are extremely delicate.

Dorsal group.—The abductor pollicis is a very distinct muscle, which stretches over the radial margin of the palm. It arises from the annular ligament, and from the scaphoid and trapezium, and is inserted into the radial aspect of the base of the first phalanx of the thumb, on the same plane as the insertions of the dorsal interossei.

The abductor minimi digiti is about the same size as the preceding muscle. It arises from the unciform bone and the annular ligament, and is inserted into the ulnar side of the first phalanx of the little finger, on the same plane as the dorsal interossei.

The dorsal interossei are four in number, and occupy the intermetacarpal spaces. They have the same connections as the corresponding muscles in man. The dorsal group of muscles, therefore, abduct the fingers from a line drawn through the middle finger.

The palmar group.—This group is composed entirely of adductors. They are four in number, and are arranged so that they antagonise the abductors. They all arise close to each other, from the palmar aspect of the carpus, and from this point they radiate to their insertions. The first is inserted into the ulnar side of the first phalanx of the thumb, and is the representative of the adductor pollicis in man; the second goes to the ulnar side of the index; the third goes to the radial side of the ring finger, and the fourth is inserted into the radial side of the little finger.

In this way, then, the abductor minimi digiti, the abductor pollicis, and the first and fourth dorsal interossei, are antagonised by four special adductors, whilst the second and third dorsal interossei act alternately as adductors and abductors of the middle finger, as in the human hand.

Intermediate group.—The muscles which constitute this group are five in number, and are placed one over the palmar aspect of each metacarpal bone. That in relation to the metacarpal bone of the thumb is the flexor brevis pollicis, and that lying upon the metacarpal bone of the little finger is the flexor brevis minimi digiti. But further, each muscle consists of two slips, which in the case of the short flexors of the thumb and little finger, remain distinct and separate from each other throughout, whilst in the case of the other three they arise by a common tendon, and only separate the one from the other at a point corresponding to the middle of the metacarpal bones. The dorsal interossei are in no way connected with these muscles.

Flexor brevis minimi digiti.—This muscle is not so strongly marked as the short flexor of the thumb. Its ulnar head arises from the unciform bone, and from the annular ligament, whilst its radial portion takes origin from the carpus somewhat deeper. They extend downwards side by side, and are inserted one into each side of the base of the first phalanx of the little finger.

Flexor brevis pollicis.—The two slips of this muscle arise close together, from the second row of carpal bones, and are inserted one into each side of the base of the first phalanx of the thumb.

The three remaining muscles of this group (viz., those which correspond to the index, middle, and ring fingers) arise partly from the base of the metacarpal bone with which each is associated, and partly from the ligamentous bands on the palmar aspect of the carpus. Half-way down the metacarpus each muscle divides into two slips, and these are continued downwards so as to embrace the base of the first phalanx of the finger with which they are connected. Here the slips end in delicate tendons, which are inserted one into each side of the phalangeal base, partly into bone and partly into the extensor tendon.

These muscles lie in series with the short flexors of the thumb and little finger, and only differ from them in having each a single origin, and in being inserted in part into the dorsal extensor expansion. Moreover, their attachments indicate a correspondence of action. When the two slips of each muscle act in unison, they must flex the fingers at the metacarpo-phalangeal joints; when they act separately and independently of each other, the action must be one of abduction or adduction, according to the slip employed, and this latter action must be performed most effectively by those muscles connected with the thumb and little finger, inasmuch as their slips are distinct from each other throughout, and not in any way hampered by the common origin of the others. The insertion of those muscles connected with the index, middle, and ring fingers into the extensor tendon, allows them to take a part in extending the fingers—a privilege which the flexor brevis pollicis and flexor brevis minimi digiti from their purely phalangeal insertions do not enjoy.

Thylacine (Pl. I. figs. 1–3).

Although the intrinsic muscles of the manus of this animal are arranged upon the same general plan as in the *Phascogale*, there are, nevertheless, certain important points of difference.

Dorsal group.—The abductor minimi digiti (figs. 1 and 3, *d*) and abductor pollicis (figs 1 and 3, *e*) are both present. The former is a very powerful muscle, and is attached, on the one hand, to the pisiform bone, and on the other to the ulnar face of the base of the first phalanx of the little finger. The abductor of the thumb is poorly developed, and with difficulty separated from the radial part of the flexor brevis pollicis. Its connections are similar to those of the corresponding muscle in the *Phascogale*.

The dorsal interossei are four in number when we view the dorsal aspect of the manus, but they are not all abductors in their action (fig. 2, d^1, d^2, d^3, d^4). The first and fourth alone have this action. The first is inserted by a single tendon upon the radial face of the first phalanx of the index, partly into bone and partly into the extensor tendon. The fourth is inserted similarly into the ulnar side of the ring finger. These muscles, therefore, abduct the index and ring fingers from the middle line of the hand. Very different is the action of the second and third dorsal interossei (d^2 and d^3). The former ends in a strong tendon which splits into two slips, and these are inserted one upon the radial face of the first phalanx of the middle finger, and the other upon the ulnar face of the first phalanx of the index. The third dorsal interosseous is inserted in precisely the same manner into the middle and ring fingers. The first and fourth dorsal interossei muscles abduct the ring and index from the middle line of the hand; the second and third approximate the three middle digits in the first instance, and then extend them.

Such are the connections of the dorsal interossei when viewed upon the dorsal aspect of the hand, but if we examine them upon their palmar surfaces after the removal of the palmar and intermediate muscles, we find an accessory slip in connection with each of the three ulnar muscles. These slips are apt to be confounded with the intermediate muscles, but careful dissection shows that they belong to the dorsal interossei. Two arise from the base of the middle metacarpal bone,—one from each side of it,—and they are inserted one into each side of the base of the first phalanx of the same finger. These are the abductors of the middle finger. The third slip arises from the base of the metacarpal bone of the ring finger (fig. 3, *h*), and is inserted into the ulnar side of the base of the corresponding phalanx. It is an accessory abductor of the ring finger.

Palmar group.—This group consists of three well-marked muscles lying upon the intermediate paired muscles, viz., (1) a large adductor of the little finger (fig. 1, *c*, and fig. 3, *c*, and c^1); (2) an abductor of the ring finger (figs. 1 and 3, *b*); (3) an adductor of the index (figs. 1 and 3, *a*).

These muscles have the same insertions as the corresponding muscles in *Phascogale*. They all arise from the front of the carpus—the adductors of the ring finger and index by a common tendon (fig. 3, *a.b*), and partly under cover of the origin of the adductor minimi digiti (fig. 3, *c*.) The adductor of the thumb is fused with the ulnar portion of the flexor brevis pollicis, but in one dissection it was readily separated as a distinct and exceedingly slender slip, having the same attachments as in the *Phascogale*.

The intermediate group of muscles (figs. 1 and 3, g^1 to g^6) corresponds in all respects with the same muscles in the *Phascogale*. At first sight they seem more complicated in their arrangement from the accessory slips of the dorsal interossei being associated with them.

Opponens pollicis.—This muscle is only present in the form of a few fibres, which pass from the conjoined abductor pollicis and radial part of the flexor brevis pollicis to the metacarpal bone.

The Palmaris brevis is very strongly marked. It cannot be considered as belonging to any one of the three groups of intrinsic muscles. It consists of two fleshy slips, both of which arise from the superficial aspect of the annular ligament. The smaller of these is inserted into the flexor sheath of the little finger, whilst the larger is attached to the ulnar side of the base of the first phalanx of the same finger.

Cuscus (Pl. II. figs. 2–3).

The abductors of the little finger (fig. 3, *d*) and thumb (fig. 3, *e*) are both present The former is more strongly developed than the latter, which is more or less completely fused with the radial head of the flexor brevis pollicis.

The four dorsal interossei differ somewhat in their relative sizes and mode of origin (fig. 2). The first, or abductor indicis (d^1) is very small, and consists of a single fleshy band, which arises from the palmar surface of the base of the metacarpal bone of the thumb, and is inserted into the radial side of the first phalanx of the index. The other three cannot be said to occupy the intermetacarpal spaces, inasmuch as they arise entirely from the dorsal surfaces of the metacarpal bones. The second (d^2) is the largest, and arises by two parts from the second and third metacarpal bones; the third (d^3) springs from the metacarpal bone of the ring finger; and the fourth (d^4) from the metacarpals of the ring and little fingers. They are inserted as in man, with the exception of the third, which, like the same muscle in the *Thylacine*, is inserted into the bases of the two fingers, between which it lies. Whilst the other dorsal interossei act as abductors of the fingers, the third approximates, and then extends the ring and middle fingers.

In the *Cuscus* there is a very beautiful arrangement by means of which the abducting power of these muscles is increased. The tendon of insertion of each muscle, with the exception of the abductor indicis, is fixed by a little transverse fibrous band to the head

of the metacarpal bone of the finger, which lies adjacent to that into which the muscle is inserted. By this the muscle is enabled to act at a greater advantage, because its tendon is prevented from clinging too closely to the base of the phalanx upon which it is acting. A similar arrangement can be made out in the *Thylacine*, but here the bands are weak in comparison with those found in the *Cuscus*.

The dorsal interrossei muscles of the *Cuscus* are provided with the same accessory slips in connection with their palmar surfaces as those we have already seen in the *Thylacine*. They are not nearly so well developed, however, and they are differently placed. The first is an adductor of the index; the second abducts the middle finger to the ulnar side of the hand; and the third abducts the ring finger. They are attached to the fingers with which they are associated in the same manner as in the *Thylacine*.

Palmar group (fig. 3).—The muscles which compose this group are the same as those in the two preceding animals, viz., (1) an adductor pollicis (*h*); (2) an adductor minimi digiti (*c*); (3) an adductor indicis (*a*); (4) and an adductor of the ring finger (*b*).

In man we see the adductor pollicis arising along the middle line of the hand from the middle metacarpal bone. It adopts this origin in order that it may obtain a more powerful action upon the thumb, and have a standpoint by means of which it may draw the thumb more completely across the palm of the hand. In the *Thylacine* and *Phascogale* there is also a tendency for the adductor muscles to seek the middle line of the hand for their origins. They arise close to each other, and then radiate towards their insertions. In the *Cuscus* all the adductors arise from the middle line, but in a different manner from the adductor pollicis in man. A median fibrous raphe extends downwards from the base of the metacarpal bone of the middle finger, and the adductors arise from each side of this. Thus the adductor pollicis and adductor mimimi digiti spring from the upper two-thirds of the raphe, the one opposite the other. They also arise, however, by a few fibres from the front of the carpus. The adductors of the index and ring fingers are very small, and take origin from the raphe below the preceding and also opposite each other. A few fibres forming a fleshy fasciculus (*a.b*), in front of the raphe, and in no way connected with it, pass round the base of the middle finger, and are attached, on the one hand, to the adductor tendon of the ring finger, and, on the other, to the adductor tendon of the index finger. It is an adductor of these fingers, but having no intermediate attachment, it must act upon both fingers simultaneously.

These muscles constitute with the raphe a thin stratum which hides from view the greater number of the intermediate muscles.

The *intermediate group* of muscles requires no special description. They agree in all essential points with the same muscles in the *Thylacine* and *Phascogale*. Of the two slips which compose the individual muscles it is somewhat curious to observe that whereas one is always inserted directly into the phalanx, the other has both an attachment to the phalanx and to the dorsal expansion of the extensor tendon. The flexor

brevis pollicis (fig. 3, g^1) and flexor minimi digiti (fig. 3, g^5) are exceptions to this rule, as both slips of each of these muscles are fixed directly to the bone.

The opponens minimi digiti is very distinct, but fused with the ulnar part of the short flexor. It is inserted into the lower half of the ulnar margin of the metacarpal bone of the little finger. This insertion is quite continuous with that of the short flexor of the same finger into the ulnar face of the first phalanx. There is no trace of an opponens pollicis.

The foregoing observations upon the intrinsic muscles of the hand are based upon four dissections of the manus of the *Thylacine*, two of the *Cuscus*, and one of the *Phascogale*. In addition I have also examined the hand of the *Vulpine phalanger*, the *Dasyurus viverrinus*, and the Australian wild Dog or Dingo, with the view of comparing the same muscles in them with those of the animals in which I was more specially interested.

The *Vulpine phalanger* in its hand muscles closely resembles the *Cuscus*, but the adductor or palmar group is feebly represented, and consequently the median raphe is not so well seen. The flexor brevis pollicis and the flexor brevis minimi digiti are apparently only represented by their radial and ulnar heads respectively, but these are strongly developed.

An opponens minimi digiti in all respects like that of the *Cuscus* is to be found, also a few fibres passing to the metacarpal bone of the thumb from the short flexor of that finger. The latter may represent an opponens pollicis.

The *Dasyurus*, on the other hand, agrees with the *Phascogale*. It has a powerful palmaris brevis similar to the same muscle in the *Thylacine*, and like the *Vulpine phalanger* it seems to be deficient in the adducting portions of the short flexors of the thumb and little fingers.

In the hand of the Dingo the metacarpal bones are compressed together so as to obliterate the intermetacarpal spaces, and in consequence of this the interossei muscles are situated in the palm. The clear definition between the three groups of muscles is therefore lost, more or less complete fusion of certain muscles takes place, and the arrangement is more difficult to interpret.

The abductors of the little finger and thumb are both present, but the latter is very rudimentary, like the digit upon which it acts. The four dorsal interossei lie upon the palmar surface of the metacarpal bones, and are fused to a certain extent with the representatives of the intermediate muscles in the Marsupials. They are poorly developed, and have the same insertions as the corresponding muscles in man.

The palmar muscles are three in number—(1) adductor pollicis, a very minute slip; (2) an adductor indicis; (3) an adductor minimi digiti.

The intermediate flexors are very similar to the same muscles in Marsupials, but the flexor brevis pollicis is suppressed, and the minute pollex is in this case flexed by the combined action of its abductor and adductor.

A few fibres of the adductor minimi digiti go to the radial margin of the metacarpal bone of this digit, and on this account it has been described as the opponens minimi digiti by veterinary anatomists.

But this description of the muscles of the hand of the Dingo does not agree with that given by Chauveau[1] of the same muscles in the domestic Dog. This author describes a flexor brevis pollicis, and speaks of an opponens pollicis and an opponens minimi digiti. The two latter are the representatives of the adductors of these fingers in man. Further, the muscle which he designates the adductor minimi digiti is in reality the abductor. Lastly, he looks upon the partially fused intermediary muscles and the dorsal interossei as composing a single series of muscles which he calls the metacarpal interossei.

The arrangement of the hand muscles in the Cat seems to be very similar to that in the Dog. Strauss-Durckheim, in his elaborate work upon the Anatomy of the Cat, gives a very careful account of these muscles. It is unfortunate that he has chosen for them a mode of nomenclature which renders his descriptions very obscure. He discards the term interossei, and calls all the intrinsic muscles of the hand adductors or abductors, according as they draw the digits towards or away from the middle line of the body. This leads to confusion, and it is only by a reference to his magnificent plates that his meaning can be clearly made out. He distinguishes three kinds of abductors and adductors, viz., short, middle, and long, according as they are inserted into the sesamoid bone, the base of the first phalanx or the second phalanx through the medium of the extensor tendon.

The above account of the intrinsic muscles of the manus was published in the form of an abstract in the Journal of Anatomy and Physiology (vol. xii.). Since then Dr. A. H. Young has greatly supplemented our knowledge of these muscles in the Marsupialia by describing them in five different species, viz., in the Opossum, the Wallaby, the Yellow-footed Rock Kangaroo, and the Wombat (Jour. Anat. and Phys., vol. xiv.), and still more recently in the Koala (Jour. Anat. and Phys., vol. xvi.). In all of these the arrangement of the intrinsic muscles is trilaminar.

The homologies of the intrinsic muscles will be fully discussed when we consider the corresponding muscles of the foot.

The Nerves of the Fore Limb of the *Thylacine* and *Cuscus*.

Swan, in his work upon the Comparative Anatomy of the Nervous System (p. 193), justly remarks that, as a general rule, the number of nerves entering into the composition of the brachial plexus in Mammalia is greatly influenced by the length of the neck. The number of vertebræ being, as a rule, the same, it follows that, when the neck is a lengthy one, the nerves are placed at greater intervals from each other, and in consequence of

[1] Comparative Anatomy.

this, fewer of the nerves take part in the formation of the plexus. This is very well exemplified in the case of the Dolphin and Ass respectively. In the former, where the cervical vertebræ are all compressed together so as to reduce the neck to a minimum, we find that the plexus is formed by the posterior five cervical nerves and the first two dorsal nerves.[1] In the Ass,[2] on the other hand, the last two cervical nerves and the first dorsal nerve are the only nerves which take part in the formation of the plexus. In the Horse and in Ruminants[3] the brachial nerves are represented by the last three cervical and the first and second dorsal nerves, and in man and animals with a neck of medium length the plexus is formed by the last four cervical nerves and the first and second dorsal nerves, as, for example, the Dog,[4] the Cat,[5] &c.

But this rule does not hold good in every case. In the Pig,[6] whose neck cannot be called long, the plexus is formed by the same nerves as in the Ass, and the Jaguar and the Fox[6] in this respect resemble the Horse.

In both the *Thylacine* (Pl. I. fig. 6) and *Cuscus* (Pl. II. fig. 6) the brachial plexus is formed, as in man, by the anterior primary divisions of the posterior four cervical nerves and of the first dorsal nerve. In the *Thylacine*, however, only a portion of the 5th cervical nerve enters the plexus. The 5th cervical nerve in this animal divides into two equal parts close to the intervertebral foramen, and diverging widely from each other, the posterior of these joins the plexus, whilst the anterior proceeds forwards under cover of the omo-hyoid muscle (*a*), and joins the 4th cervical nerve. It also gives cutaneous twigs to the neck and outer and dorsal aspects of the shoulder (*b* and *c*).

In the *Thylacine* the branches entering into the constitution of the brachial plexus join so as to present a more or less looped appearance, but the general plan of the plexus is very indefinite, irregular, and complicated (Pl. I. fig. 6).

The branches which proceed from it arise in the following manner:—(1) From the 5th and 6th cervical nerves the suprascapular (*s.*), the phrenic (*p.*), and the nerve to the subclavius (*s.c.*); (2) from the 6th and 7th the subscapular nerves (*s.s.*) and the external respiratory (*e.r.*); (3) from the 7th muscular branches to the panniculus carnosus (*p.c.*) and pectoral muscles (*p.m.*), the circumflex (*c.f.*), and the nerves corresponding to the musculo-cutaneous in man (*m.c.*); (4) from the 7th, 8th, and 1st dorsal the median (*m.*) and musculo-spiral (*m.s.*); (5) from the 8th and 1st dorsal the ulnar (*u.*) and internal cutaneous (*i.c.*).

In the *Cuscus* the brachial nerves have a more definite arrangement (Pl. II. fig. 6). They first unite so as to form four nervous loops, and from these two large trunks proceed—the one deriving fibres from the 5th, 6th, and 7th cervical nerves, and the other

[1] Spinal Nervous System of the Porpoise and Dolphin, Jour. Anat. and Phys., p. 217, 1876.
[2] Swan's Comparative Anatomy of the Nervous System. [3] Chauveau's Comparative Anatomy.
[4] Graduation Thesis on the Anatomy of the Dog, by J. H. Scott, M.D., unpublished, but to be consulted in the Library of the University of Edinburgh.
[5] Chauveau's Comparative Anatomy. [6] Swan's Comparative Anatomy of the Nervous System.

from the 8th cervical and 1st dorsal nerves—and embracing the axillary artery, they unite in the form of a flattened nervous band which lies upon the inner aspect of the axillary artery, between it and the vein. The principal branches of the plexus spring from this band.

The branches of the plexus may be conveniently classified under two heads :—(1) Those arising from the primary looped plexus ; (2) those which take origin from the flattened nervous band or plexus proper.

The first group includes—(1) the suprascapular (*s.*), phrenic (*p.*), and nerve to the subclavius (*s.c.*), all proceeding from the 5th and 6th nerves ; (2) the subscapulars (*s.s.*) coming—one from the 5th and 6th, and two from the 6th, 7th, and 8th ; (3) the external respiratory (*e.r.*) from the 6th and 7th ; (4) the circumflex (*c.*) from the 6th, 7th, and 8th ; (5) the musculo-spiral (*m.s.*) from the 7th, 8th, and 1st dorsal nerves.

The plexus proper gives orgin to the musculo-cutaneous (*m.c.*), median (*m.*), ulnar (*u.*), internal cutaneous (*i.c.*), and muscular branches to the panniculus carnosus (*p.c.*) and pectoral muscles (*p.m.*).

In the upper arm and forearm the distribution of the brachial nerves is very similar in the two animals, and, consequently, in this part of their course one description will suffice for both. In the manus, however, certain points of dissimilarity must be noted.

Circumflex (Pl. I. fig. 6, *c.f.* ; Pl. II. fig. 4, *c.n.*, and fig. 6, *c.*).—This is a large nerve, and has a more extensive cutaneous distribution than the corresponding nerve in man. It takes the usual course through the quadrilateral space, and round the neck of the humerus to reach the deep surface of the deltoid. Here it divides into two branches of equal size. Of these one immediately splits up into twigs for the supply of the deltoid and the teres minor. The other branch is cutaneous, and has a wide area of distribution. Emerging from under cover of the deltoid (Pl. I. fig. 5, *c.*) it becomes superficial upon the outer aspect of the upper arm, and not only supplies the skin in this locality, but is also continued downwards to the outer aspect of the forearm. This portion of the circumflex nerve is to be regarded as the substitute for the cutaneous part of the musculo-cutaneous in man, which is absent in these animals. It is interesting to note that in the Porpoise and Dolphin[1] a great part of the circumflex nerve is distributed as in *Thylacine* and *Cuscus* to the skin over the radial aspect of the arm and forearm.

Musculo-cutaneous (Pl. I. fig. 6, *m.c.* ; Pl. II. fig. 6, *m.c.*, and fig. 4, *m.c.n.* and *m.c.n*^{1}.). —This is a purely motor nerve, distributed only to muscles, and consequently the term "musculo-cutaneous" is a misnomer. It comes off in two parts. One of these passes outwards to supply the short coraco-brachialis, and the superficial biceps (Pl. II. fig. 4, *m.c.n*^{1}.), whilst the other passes obliquely downwards and outwards towards the elbow-joint, to supply the deep portion of the biceps and the brachialis anticus (Pl. II. fig. 4, *m.c.n.*). In the *Cuscus*, in which there is a well developed coraco-brachialis

[1] Cunningham, Spinal Nervous System of the Porpoise and Dolphin, Jour. Anat. and Phys., 1876.

longus, both nerves pass under cover of it to reach their destination, and the lower nerve supplies it. As a sensory nerve to the outer aspect of the fore limb, the musculo-cutaneous finds a substitute in the cutaneous division of the circumflex. It is by no means uncommon for the musculo-cutaneous to have a purely motor function. According to Swan,[1] this is the case in the Fox, and its place is here supplied by branches which spring from one of the long roots of the median, a little way above the elbow. In the Dog and the Cat it has the usual double distribution.[2]

Musculo-spiral (Pl. I. fig. 6, *m.s.*; Pl. II. fig. 4, *m.s.n.*, and fig. 6, *m.s.*).—This nerve does not end in front of the elbow by dividing into a radial and a posterior interosseous division. It is carried downwards to the extensor aspect of the forearm as one undivided trunk.

In its course it closely corresponds with the same nerve in other Mammals. Passing, in the first instance, downwards, it soon pierces the internal head of the triceps in the *Thylacine*, but in the *Cuscus* runs behind the humerus between the outer and inner heads of the muscle. It then comes forward through the external intermuscular septum, and continues its course to the elbow-joint upon the supra-condyloid ridge, and lies deeply in the interval between the supinator longus and the brachialis anticus. In the *Thylacine*, in which the supinator longus is poorly developed, it lies between the extensor carpi radialis longior and the brachialis anticus. At a lower level it lies directly upon the anterior ligament of the elbow-joint, and then diverging outwards and backwards it winds round the neck of the radius under cover of the supinator brevis in *Thylacinus*, but through its midst in the *Cuscus*, and thus gains the extensor aspect of the forearm. Here it is placed between the superficial and deep layers of extensor muscles, and ends by giving off numerous branches to the neighbouring muscles and one large cutaneous nerve (Pl. II. fig. 5, *m.s.n.*).

Branches.—On the inner aspect of the arm, before it pierces the inner head of the triceps, it supplies twigs to the middle and inner heads of the triceps, and also to the dorsi-epitrochlear muscle (Pl. II. fig. 4, *d.e.n.*), thus showing that this latter muscle must be associated with the triceps, and not with the latissimus dorsi from which it springs. Behind the humerus branches are given to the external head of the triceps; and on the outer aspect of the arm, before it passes under cover of the supinator brevis, it yields twigs to the supinator longus, extensor carpi radialis longior and brevior, and to the superficial aspect of the supinator brevis. On the dorsal aspect of the forearm (Pl. II. fig. 5, *m.s.n.*) it supplies all the extensor muscles, and the anconeus externus in the case of the *Cuscus*. The cutaneous branch is the direct continuation downwards of the nerve itself. It becomes superficial about the middle of the forearm by coming out between the extensor communis digitorum and the extensor secundus digitorum (*i.e.*, extensor

[1] Swan's Comparative Anatomy of the Nervous System.
[2] Chauveau's Comparative Anatomy.

minimi digiti), and giving a few twigs to the skin in this region, it is continued downwards in the *Cuscus* to the dorsum of the hand, where it ends in three branches which go one to the skin on each side of the middle finger, and the third to the radial side of the ring finger. In the *Thylacine* the nerve does not give any dorsal digital branches. It ends on the back of the wrist.

This cutaneous branch of the musculo-spiral is not the representative of the radial nerve in man. It is clearly the posterior interosseous nerve. A branch somewhat analogous to the radial is given off by the median.

Median (Pl. I. fig. 6, *m.*; Pl. II. fig. 4, *m.n.*, and fig. 6, *m.*).—This is the largest branch of the brachial plexus. In the upper arm it lies in close company with the humeral artery, and with it passes through the supra-condyloid foramen. In front of the elbow-joint it sinks deeply under cover of the pronator radii teres, and ends by dividing into (1) a superficial or radial branch, (2) the median proper. In the upper arm the main trunk gives off no branches; as it lies under cover of the pronator radii teres, however, it supplies twigs to each of the divisions of the flexor muscle, and also to the flexor carpi radialis. The twig to the ulnar portion of the flexor muscle—that part which represents the flexor profundus digitorum is very small.

Superficial or medio-radial nerve.—This nerve seems to take the place of the radial branch of the musculo-spiral which we have seen to be absent. It becomes superficial about the middle of the flexor aspect of the forearm, by appearing in the interval between the pronator teres and the flexor carpi radialis. It ends a short way above the wrist by dividing into a dorsal and a palmar branch (Pl. II. fig. 3, *m.r.n.*). In the forearm, before it comes to the surface, it gives off a few twigs to the pronator teres, and a long slender branch to the superficial aspect of the pronator quadratus. The latter accompanies the anterior interosseous artery, and is the representative of the interosseous branch of the median in man.

The palmar branch (Pl. II. fig. 3, *m.r.n.*) of the medio-radial nerve enters the palm by passing over the annular ligament in company with the superficial artery of the forearm, and after giving numerous twigs to the palmar pads, and a branch to the abductor pollicis and the radial and ulnar parts of the flexor brevis pollicis, it ends as the palmar digital nerve for the radial side of the thumb.

In the *Thylacine* the dorsal branch is much the larger of the two, and winding round the radial border of the forearm to the dorsal aspect of the wrist, it gives off a few twigs to the skin, and ends in dorsal digital branches for both sides of the thumb, index, and middle fingers, and the radial side of the ring finger. In the *Cuscus* it merely supplies digital branches to the pollex and index. The middle finger and the radial side of the ring finger in this case derive their nerve supply from the superficial branch of the musculo-spiral.

Median proper.—This nerve, accompanied by the main artery of the forearm, proceeds

downwards, and passing under cover of the flexor carpi radialis and the anterior annular ligament, enters the palm. It gives off no branches in the forearm. In the *Thylacine* the palmar branches are very numerous. Eight distinct twigs are given to the palmar pads, and then the nerve ends in digital branches which supply the palmar aspect of all the fingers with the exception of the radial side of the thumb and the ulnar side of the little finger. In the *Cuscus* the branches to the skin of the palm are not so plentiful, and digital twigs are only given to the index and middle fingers and to the ulnar side of the thumb and the radial side of the ring finger. In both animals the median nerve supplies all the lumbrical muscles. It also communicates freely with the palmar branches of the ulnar nerve on the one hand and medio-radial nerve on the other.

The ulnar nerve (Pl. I. fig. 6, *u.*; Pl. II. fig. 4, *u.n.*; Pl. II. fig. 3, *u.n.*) crosses the axillary vein, and running down the inner aspect of the limb to the interval between the olecranon and internal condyle of the humerus, it enters the forearm by passing under cover of the anconeus internus. In the forearm it lies between the ulnar flexor of the carpus and the ulnar part of the flexor muscle, and it ends at the junction of the middle and lower thirds of the forearm by dividing into a palmar (Pl. II. fig. 3, *u.n.*) and a dorsal branch. It supplies the anconeus internus, flexor carpi ulnaris, and a few small twigs proceed from it to the ulnar and condylar parts of the flexor muscle.

The palmar portion of the nerve, as it approaches the pisiform bone, divides into a superficial and a deep division. The former goes to the ulnar margin of the hand, supplies the abductor minimi digiti, and then proceeds onwards as the palmar digital branch for the ulnar side of the little finger. The deep division crosses the annular ligament superficially, under the shadow of the pisiform bone, and enters the palm. It at once sinks under cover of the ulnar head of the flexor brevis minimi digiti, and turning outwards is carried across the palm towards the radial margin of the hand between the plantar and intermediate strata of intrinsic muscles. It is expended in the supply of all the adductors, the dorsal interossei, and the short flexors, with the exception of the flexor brevis pollicis. In the *Cuscus* it supplies, in addition to these muscular twigs, the digital branch for the adjacent sides of the ring and little fingers. This nerve emerges from under cover of the adductor annularis (Pl. II. fig. 3, *d.n.*). In both it gives off branches to the skin of the palm.

The dorsal branch of the ulnar nerve winds round the ulnar margin of the forearm under cover of the tendon of the flexor carpi ulnaris, and it ends in digital branches for both sides of the little finger and the ulnar side of the ring finger.

The number of nerves which are given to the skin of the palm in the *Thylacine* is very surprising. Each of the three palmar nerves contributes to its supply—the median alone giving eight twigs. This seems to indicate that the palmar skin possesses an unusually high degree of sensibility.

Myology of the Hind Limb.

I regret that in this chapter I am only able to give an account of the myology of the hind limb in the *Thylacine* and *Cuscus*. The pelvis and posterior limbs of the *Phascogale* were so shattered with shot that it was impossible to conduct a proper examination of their anatomy.

Gluteal Region.

Gluteus maximus (ecto-gluteus) (Pl. III. fig. 1, *ec.g*^{1}., *ec.g*^{2}., *ec.g*^{3}.; and Pl. IV. fig. 5, *ec.g*^{1}. and *ec.g*^{2}.).—In the *Cuscus* the gluteus maximus is represented by three muscles all occupying the same plane, and placed superficial to the other structures of the gluteal region. These three muscles arise in a continuous line from the anterior superior spine of the ilium in front to the fourth caudal vertebra behind. The two posterior muscles are only partially separated from each other, and they together represent the agitator caudæ. The anterior muscle is the combined gluteus maximus and tensor fasciæ femoris.

The agitator caudæ (Pl. III. fig. 1, *ec.g*^{2}., *ec.g*^{3}.) is a large, powerful muscle. Its anterior and smaller portion arises from the fascia over the hinder part of the sacrum and from the first caudal vertebra; the wider posterior portion springs from the fascia over the second caudal vertebra and from the transverse processes of the third, fourth, and fifth caudal vertebræ. Both portions of the muscle are inserted into the posterior aspect of the femur in a continuous line from the root of the great trochanter above to within an inch of the external condyle below (*ec.g*^{2}. × and *ec.g*^{3}. ×).

The combined gluteus maximus and tensor fasciæ femoris (Pl. III. fig. 1, *ec.g*^{1}.) is a thin layer of muscular fibres which arises from the fascia over the last lumbar vertebra and the sacrum, from the fascia over the gluteus medius (meso-gluteus) muscle and also from a tendinous cord which passes horizontally backwards from the anterior superior spine of the ilium. This fibrous cord is fully an inch and a half long, and gives origin by its superior border to the three gluteal muscles, whilst by its inferior margin it gives attachment to the sartorius and the obliquus internus. At first sight it has the appearance of being the representative of Poupart's ligament, but it cannot in any respect be considered the homologue of this structure, seeing that the aponeurosis of the external oblique is in no way connected with it. The gluteus maximus is inserted into the outer aspect of the root of the great trochanter, and also slightly into the posterior aspect of the shaft of the bone below this. The posterior margin of the muscle is free, and quite distinct from the agitator caudæ; in front, however, it winds round the anterior border of the meso-gluteus (Pl. III. fig. 1, *ec.g*^{1}. ×), and becomes inseparably connected with the gluteus minimus (endo-gluteus). In this manner, therefore, the superficial and deep gluteal muscles enclose the meso-gluteus on all sides except posteriorly. That the anterior fibres of the muscle just described represent the tensor

fasciæ femoris is shown by the fact that a twig from the superior gluteal nerve can be traced into their midst (Pl. III. fig. 1, *s.g.n.*).

In almost all the muscles of the gluteal region of *Thylacinus* there is a marked tendency to segmentation. The gluteus maximus (Pl. IV. fig. 5, *ec.g*^{1}. and *ec.g*^{2}.) differs materially from the corresponding muscle in *Cuscus*. It consists of two portions which lie one behind the other, and each is segmented into a superficial and deep part. The posterior division represents the agitator caudæ. The anterior part or gluteus maximus proper lies altogether behind the gluteus medius (meso-gluteus). Its superficial segment springs from the fascia on the dorsal aspect of the sacrum. It is a thin fleshy stratum which is inserted into the back part of the great trochanter (*ec.g*^{1}*.). The deep segment, narrower but more fleshy than the superficial part, takes origin from the side of the sacrum in its posterior half, and also from the fascia on the dorsum of the sacrum; it emerges from under cover of the superficial segment near the trochanter major, and is inserted into the posterior aspect of the femur immediately below its fellow (*ec.g*^{1}*.).

The agitator caudæ (*ec.g*^{2}.) by its superficial segment springs from the fascia over the anterior three caudal vertebræ, and by its deep segment from the transverse process of the second caudal vertebra. The latter is a very narrow band, and after a short independent course they unite to be inserted into the posterior aspect of the femur below the deep segment of the gluteus maximus (*ec.g*^{2}*.).

The four muscular factors which in *Thylacinus* thus represent the gluteus maximus in man are supplied by a special nerve from the sacral plexus. In the *Thylacine* there is apparently no trace of the tensor fasciæ femoris.

Gluteus medius (meso-gluteus).—In both animals this muscle is powerfully developed and quite distinct from the gluteus minimus. In *Cuscus* (Pl. III. fig. 1, *m.g.*) it is a thick fleshy muscle which arises from the short iliac crest, from the dorsum ilii, from the fascia covering it, and from the tendinous cord already referred to as giving common origin to the three gluteal muscles. It is inserted into the summit and outer aspect of the great trochanter of the femur (*m.g.* +).

The gluteus medius in the *Thylacine* (Pl. IV. fig. 5, *m.g.*) is segmented into a superficial and deep portion. The former is inserted into the outer aspect of the great trochanter (*m.g**.), whilst the latter is attached to its summit. The deep segment is not so broad or fleshy as the superficial part, and is received into a deep hollow in its under surface, so that at first sight it appears as if the one segment were enclosed within the substance of the other.

In the Koala[1] the gluteus medius is also frequently bilaminar.

Gluteus minimus.—This muscle is quite distinct in both animals from the gluteus

[1] Young, Muscular Anatomy of the Koala, Jour. Anat. and Phys., vol. xvi. p. 234.

medius. According to Macalister[1] the two muscles are hardly separable in the Wombat and *Sarcophilus*. As a general rule, however, in Marsupialia they are quite distinct. It is a wide thin muscle which arises in both instances from the dorsum ilii and from the ischium as far back as the gemelli. It thus almost completely covers the superior aspect of the hip-joint (Pl. III. fig. 1, *en.g.*, and Pl. IV. fig. 5, *en.g.*). In the *Cuscus* its anterior border is blended with the corresponding margin of the gluteus maximus. It narrows towards its insertion, and all its fibres converge to be attached to the anterior border of the great trochanter of the femur.

Gluteus quartus.—In *Thylacinus* this muscle is well developed (Pl. IV. fig. 2, *g.q.*). Somewhat triangular in shape it springs by a pointed origin from the margin of the acetabulum close to the reflected tendon of the rectus femoris (*r.f*[2].). Expanding as it proceeds downwards over the anterior aspect of the capsule of the hip-joint, it enters the interval between the vastus externus and vastus internus, and is inserted into the front of the shaft of the femur immediately below the neck. In the *Cuscus* the gluteus quartus is also present, but it is very feebly marked, and consists of a single delicate muscular slip.

In neither case was I able to make out with precision the nerve supply. Until this is done the homologies of this minute muscle cannot be considered as established. Although usually grouped with the gluteal muscles it seems to have a closer relationship to the extensor muscles. It is generally present in Marsupialia. Macalister[1] describes it in the Wombat, *Sarcophilus*, Giant Kangaroo, Bennett's Kangaroo, the *Phalanger*, and the Opossum. Neither Macalister[2] nor Young[3] mention it as existing in the Koala.

Pyriformis.—This is a strongly-marked triangular muscle, which lies upon the posterior part of the gluteus minimus behind the gluteus medius (Pl. III. fig. 1, *p.*; and Pl. IV. fig. 5, *p.*). It springs from the lower surface and outer margin of the sacrum, and is inserted by a rounded tendon into the posterior part of the summit of the great trochanter. It is identical in both animals. Macalister[1] states that it is "undistinguishable from the gluteus medius in the *Phalangista*."

Ischio-femoral (Pl. III. fig. 1, *i.f.*, and Pl. IV. fig. 5, *i.f.*).—This muscle is commonly described as the quadratus femoris, but it lies on a different plane, viz., superficial to the gemelli, the true quadratus and the adductor magnus. It seems to me therefore that it must be regarded as a separate muscle, the precise nature of which is doubtful. It is an exceedingly thin fleshy band which arises from the great sacro-sciatic ligament, and is inserted into the posterior aspect of the femur below the great trochanter between the insertions of the ecto-gluteus and the adductor magnus. It is more strongly marked in the *Thylacine* than in the *Cuscus*, and its deep surface is partially fused with the subjacent adductor magnus.

[1] Myology of the Wombat and Tasmanian Devil, Ann. and Mag. Nat. Hist., vol. v., 4th series, p. 167.
[2] Muscular Anatomy of Koala, Ann. and Mag. Nat. Hist., vol. x., 4th series.
[3] Young, Anatomy of Koala, Jour. of Anat. and Phys., vol. xvi.

Obturator internus and gemelli.—The obturator internus is present in both the *Thylacine* and *Cuscus*. It is strongly developed in the latter, but comparatively feeble in the former. In both, its tendon plays in the small sciatic notch, but the encrusting cartilage of this is not raised into ridges, and thus the tendon does not display the longitudinal furrows which are so characteristic of the same muscle in man. It is inserted along with the obturator externus into the bottom of a deep recess which exists between the great trochanter and the neck of the femur.

The gemelli are enormously developed. In the *Cuscus* they are inseparable except at their origin. The superior (or anterior) gemellus springs from the ischium in front of the small sciatic notch, whilst the inferior (posterior) gemellus arises from the tuber ischii. The tendon of the obturator internus lies in a groove in their substance, and they are inserted into this tendon. The nerve to the quadratus femoris passes downwards through the substance of the gemelli.

In the *Thylacine* the gemelli are still more strongly marked, and each consists of a superficial and deep segment. These fuse as they pass towards their insertion, which is partly into the tendon of the obturator internus, but chiefly into the recess between the great trochanter and the neck of the femur. The nerve to the quadratus femoris passes downwards between the segments of the gemellus superior, but under cover of both parts of the gemellus inferior.

Obturator externus.—This is an exceedingly powerful fan-shaped muscle, which presents the usual origin in both animals. It is inserted by a broad band-like tendon into the trochanteric fossa below the tendon of the obturator internus.

Quadratus femoris.—This is a thick fleshy muscle, which lies upon the same plane as the adductor magnus, and is quite separate from it in the *Cuscus*, although in *Thylacinus* it is partially fused with its upper border. It arises from the tuber ischii, and is inserted into the lower part of the posterior border of the great trochanter, and also into the posterior aspect of the shaft of the femur below this for nearly an inch. As compared with the corresponding muscle in man, it is relatively larger, and its fibres are more oblique and coarser.

Hamstring Muscles.

In both *Thylacinus* and *Cuscus* we find the following hamstring muscles:—(1) The biceps with its accessory parts, (2) the semi-tendinosus, and (3) the semi-membranosus.

Biceps.—This muscle presents the simplest arrangement in the *Cuscus*. It is composed of two distinct parts, viz., an ischial part or biceps proper and a caudal part.

The biceps proper (Pl. III. fig. 1, *b*.) arises by a narrow and pointed origin from the ischial tuberosity in common with the semi-tendinosus. As it is followed downwards it rapidly expands so as to assume a marked triangular form, and it is inserted into the

fascia on the outer aspect of the leg from the external condyle of the femur in front to the external maleolus behind. It has no femoral head of origin, so that the name biceps is in this respect inappropriate.

The caudal portion (Pl. III. fig. 1, *c.t.*) of the muscle has not been noticed in any Marsupial so far as I am aware.[1] It is a long ribbon-shaped muscle, which arises in the gluteal region from the transverse processes of the first and second caudal vertebræ in the same plane as the gluteus medius, and under cover of the agitator caudæ. From this origin it proceeds downwards in the interval between the ischial tuberosity, and the great trochanter superficial to the biceps proper. The bicipiti accessorius of Haughton lies under cover of the biceps. Reaching a point opposite the posterior aspect of the knee-joint, it gives a small muscular slip to the semi-tendinosus (Pl. III. fig. 1, *s.t.*, and fig. 2, *s.*), and splits into two divisions, which diverge from each other so as to embrace the posterior aspect of the leg. The fibular division fuses with the posterior margin of the biceps proper, and is inserted with it into the fascia on the outer aspect of the leg; the tibial portion, which is the longer of the two, ends in an aponeurotic expansion which is inserted (Pl. III. fig. 2, *c.t.*) into the inner subcutaneous surface of the tibia about its middle, at a lower level than the insertion of the semi-tendinosus (Pl. III. 2, *s.t.*), and slightly overlapped by the gracilis (Pl. III. fig. 2, *g.*).

In *Thylacinus* the biceps muscle is very complicated. It consists essentially of three portions—(1) a biceps proper, (2) a superficial caudal portion, and (3) a deep caudal part. These three subdivisions are brought into close association with each other by numerous fleshy slips which pass from the one to the other.

The biceps proper (Pl. IV. fig. 5, *b.*) is more massive than in *Cuscus*, and not nearly so expanded at its insertion; indeed, it is merely inserted into the fascia over the outer aspect of the knee and upper third of the leg.

The superficial caudal division (Pl. IV. figs. 1 and 5, b^2.) of the muscle is the representative of the caudal part of the biceps in the *Cuscus*. It arises from the transverse processes of the second and third caudal vertebræ, and passing downwards upon the origin of the biceps proper it gives a slip to the semi-tendinosus (*s.t.*), and then divides into a tibial and fibular part. The tibial portion (Pl. IV. fig. 1, b^3.) is the larger of the two, and being reinforced by a slip from the semi-tendinosus it proceeds downwards along with this muscle to the inner aspect of the leg, where it is inserted into the tibia about the middle of its inner subcutaneous surface. The fibular part (Pl. IV. fig. 5, b^2.) is reinforced by a long slender slip from the biceps proper, and is inserted into the fascia on the outer aspect of the leg, behind and in conjunction with the biceps proper.

The deep caudal portion (Pl. IV. fig. 5, b^1.) of the biceps muscle represents the bicipiti accessorius of Haughton. It is a long narrow slip which springs from the transverse

[1] It appears to be figured by Cuvier and Laurillard in the Kangaroo Rat and in the Opossum (pl. clxxx. r^1 and pl. clxxiv. r^2).

process of the first caudal vertebra—on the same plane with the superficial muscle, and under cover of the agitator caudæ. It passes downwards under cover of the biceps proper, and appearing at its posterior border is inserted into the fascia on the fibular aspect of the leg.

These caudal divisions of the biceps muscle are undoubtedly present for the purpose of associating the movements of the heavy tail with those of the hind limb.

The bicepiti accessorius appears to be only occasionally present. According to Macalister[1] it is found in *Sarcophilus*, but "is absent in the Wombat, Giant Kangaroo, Bennett's Kangaroo, *Phalanger*, and Opossum. Young,[1] however, asserts its presence in the Opossum, but states that it is absent in the Koala.

Semi-tendinosus (Pl. III. fig. 1, *s.t.*, and fig. 2, *s.t.*; Pl. IV. fig. 5, *s.t.*, and fig. 1, *s.t.*).—In both animals this muscle has the usual origin from the tuber ischii, and in both its origin is partially blended with that of the biceps proper. Its connections with the supercaudal portion of the biceps have already been noticed. In *Cuscus* it is inserted into the inner aspect of the tibia about its middle, and completely under cover of the gracilis (Pl. III. fig. 2, *s.t.*); in *Thylacine* it is inserted very much higher up, and at a lower level than the gracilis (Pl. IV. fig. 1, *s.t.*).

In *Thylacine* the muscle is traversed by a faint tendinous intersection, but no such appearance was visible in *Cuscus*. It is a rare occurrence to find such in the semitendinosus of a Marsupial.

Semi-membranosus.—Little need be said about this muscle. It has the usual origin, and it ends in a round tendon which passes under cover of the strong cord-like internal lateral ligament (Pl. III. fig. 1, *i.l.l.*) of the knee to be inserted into the side of the anterior tuberosity of the tibia. It acts, therefore, as a rotator of the leg upon the thigh, as well as a powerful flexor (Pl. III. fig. 2, *s.m.*, and Pl. IV. fig. 1, *s.m.*).

Muscles on the Anterior and Inner Aspects of the Thigh.

Sartorius.—In both cases this muscle arises from the anterior superior spine of the ilium. In *Cuscus*, owing to the flexed condition of the thigh, it is at first closely applied to the lower part of the abdominal wall. Expanding into an exceedingly thin sheet of muscular fibres, it is inserted into the tendinous expansion of the quadriceps extensor muscle on the front of the knee, and also into the fascia upon the inner aspect of the joint (Pl. III. fig. 1, *s.*). In *Thylacinus* it is a thick prismatic muscle, and is inserted entirely in front of the knee-joint into the quadriceps expansion.

These animals therefore prove no exception to the rule that in Marsupialia generally the sartorius acts chiefly as an extensor of the leg upon the thigh.

[1] Myology of the Wombat and Tasmanian Devil, Ann. and Mag. Nat. Hist., vol. v., 4th ser.
[2] Muscular Anatomy of Koala, Jour. of Anat. and Phys., vol. xvi. p. 235.

Quadriceps extensor.—In both *Thylacine* and *Cuscus* the rectus femoris (Pl. III. fig. 1, *r.f.*, and Pl. IV. fig. 5, *r.f.*) has a double origin. In the latter, the reflected head is much the larger of the two; the other head, although quite distinct, is a very slender tendon indeed. In the *Thylacine*, the reflected head is also strongly marked (Pl. IV. fig. 2, $r.f^2$.), but the other head is developed to an enormous extent, and strongly reminds one of the appearance presented by the long head of the triceps in the fore limb of the same animal (Pl. I. fig. 5, $t.r^1$.). It takes origin by a thin aponeurosis which is attached to the entire length of the lower border of the ilium from the reflected tendon behind to the anterior superior spine of the ilium in front. This aponeurosis gives place to a thick fleshy triangular portion of muscle, which joins the belly of the reflected head to form the mass of the rectus femoris.

Young[1] describes the rectus femoris as possessing two heads in the Koala, and Professor Owen[2] mentions a similar condition of the muscle in *Perameles lagotis*. Macalister,[3] however, states that in *Phalangista vulpina*, the Opossum, the Wombat, the Tasmanian Devil, the Giant Kangaroo and Bennett's Kangaroo the rectus femoris arises by a single head from the anterior inferior spine of the ilium.

Of the other factors of the quadriceps the vastus externus is the most strongly developed. It alone also is partially separable from the others. The vastus internus and the crureus are intimately blended, the one with the other. In the *Cuscus* there was a very distinct subcrureus; in the *Thylacine*, however, there was no trace of such a muscle.

In neither animal is there an osseous patella, but the different portions of the quadriceps, together with the sartorius, unite to form an exceedingly dense and thick tendinous expansion in front of the knee-joint. This is so excessively tough and resistent to the knife that it almost resembles fibro-cartilage in its consistence. In the Wombat[3] it apparently attains a cartilaginous structure.

Psoas and *Iliacus.*—In the great majority of the Marsupial group the psoas parvus attains a greater size than the psoas magnus. In the two animals under consideration it is much the larger, and takes origin from the bodies of six vertebræ (viz., the last dorsal and the anterior five lumbar). It ends in a long round tendon, which is inserted into the anterior border of the pubic bone, close to the os marsupium, and immediately in front of the acetabulum.

In the *Cuscus* the psoas magnus arises from the bodies of the last two lumbar vertebræ, and also from the upper part of the sacrum. It blends with the iliacus.

In the *Thylacine* the psoas magnus consists of two distinct portions. The anterior part is the larger of the two; in front it is blended with the psoas parvus, whilst behind it springs from the bodies, and transverse processes of the last two lumbar vertebræ. It ends by joining the iliacus. The posterior portion springs from the last lumbar vertebra,

[1] Muscular Anatomy of the Koala, Jour. Anat. and Phys., vol. xvi. [2] Todd's Cyclop., vol. iii. p. 290.
[3] Muscular Anatomy of Tasmanian Devil and Wombat, Ann. and Mag. Nat. Hist., vol. v., 4th ser.

and the two first pieces of the sacrum, and it is inserted into the upper part of the small trochanter independently of the iliacus.

The iliacus springs from the lower border and iliac fossa of the ilium, and blending with the fibres of the psoas magnus it is inserted into the small trochanter and the surface of the femoral shaft immediately below this.

Gracilis.—This is a powerful broad muscular band which springs from the side of the pubic symphysis. This origin extends as high up as the antero-inferior angle of the marsupial bone, but in neither animal was the muscle in any way attached to this bone, as is the case in the majority of Marsupials. Indeed, Macalister[1] states that in every Marsupial that he has examined he has noticed an attachment of the gracilis to the marsupial bone. Young,[2] however, does not mention it in the Koala. In the *Cuscus* the gracilis (Pl. III. fig. 2, *g.*) has an extensive insertion into the anterior sharp ridge of the tibia in its middle third; in the *Thylacine* it presents a much more limited insertion into the subcutaneous surface of the tibia, a short distance below the internal tuberosity (Pl. IV. fig. 1, *g.*).

Pectineus.—In the *Cuscus* this muscle is more strongly marked than in the *Thylacine*. It presents in the former a small pointed origin from the anterior margin of the pubic bone, and also slightly from the outer and lower angle of the large marsupial bone. In the *Thylacine* it springs entirely from the cartilaginous nodule (Pl. III. fig. 1), that represents the marsupial bone, and is inserted into the femur, immediately below the small trochanter. In the *Cuscus* it expands, and has a linear insertion into the middle third of the posterior aspect of the shaft of the femur in front of the adductor brevis.

Triceps adductor.—In the *Thylacine* this muscular mass is divided as in man into three strata, but the ordinary terminology does not express the relative characters of these three strata; thus the adductor longus is the shortest muscle, the adductor brevis the bulkiest, and the adductor magnus the longest.

The adductor longus is very similar to the same muscle in man. It has a pointed origin from the base of the marsupial bone, and it expands as it passes downwards to be inserted into the middle third of the posterior aspect of the femur, where it is fused with the subjacent adductor brevis. The adductor brevis (Pl. IV. fig. 1, *a.b.*) has a wide origin from the pubic arch, and the anterior part of the ischial tuberosity. It is with difficulty separated from the adductor magnus, and it is inserted into the posterior aspect of the femur from the small trochanter above to the internal condyle below. Towards its lower part it is perforated by the femoral artery, as it passes backwards to enter the popliteal space. The adductor magnus (Pl. IV. fig. 1, *a.m.*) arises from the tuber ischii, under cover of the semi-membranosus and gracilis. It is not so bulky as the adductor brevis, and is inserted into the lower two-thirds of the posterior aspect of the shaft of the femur, and also by fleshy fibres into the inner aspect of the

[1] Ann. and Mag. Nat. Hist., vol. v., 4th ser.

[2] Journal of Anatomy and Physiology, vol. xvi.

internal condyle. Its lower margin, therefore, reaches lower down than that of the adductor brevis, and it is, in like manner pierced by the femoral artery (Pl. IV. fig. 1, *f.a.*). The quadratus femoris is in apposition with its upper border, whilst fused with it posteriorly are the lower fibres of the ischio-femoral muscle.

In the *Cuscus* (Pl. V. fig. 4) there are only two adductors present, viz., the adductor brevis and the adductor magnus. The absence of the adductor longus is rendered evident by the fact that the obturator nerve lies upon the superficial aspect of the adductor brevis.

The adductor brevis (*e*) is much the larger of the two muscles, and it completely hides the adductor magnus from the front. It has a curved origin from the base of the marsupial bone, and from the margin of the pubic symphysis, under cover of the gracilis (*f*). Its insertion is the same as the corresponding muscle in *Thylacinus*, and, like it, it is pierced by the femoral artery (e^1). The adductor magnus (*d*) is a thick fleshy strap, which arises from the arch of the pubis and the ischial tuberosity, and is inserted into the posterior aspect of the shaft of the femur in its lower third. It is not perforated by the femoral artery. The two muscles are easily separated from each other.

The triceps adductor is subject to considerable variations in the Marsupialia. Thus Macalister[1] records that the three portions are quite distinct in the Wallaby and Giant Kangaroo, whilst the adductor brevis and the adductor magnus are partially, or it may be completely, blended in the Opossum, *Sarcophilus*, Wombat, and in *Phalangista*.

Posterior Aspect of Leg.

The superficial muscles on the back of the leg are the gastrocnemius and the plantaris. In all probability the absent soleus is blended with the outer head of the gastrocnemius.

Gastrocnemius.—This muscle in *Thylacinus* arises by two very large and powerful heads. The outer head which contains the soleus is much the larger of the two, and it arises by two parts—(1) by a fleshy process fixed to a large sesamoid bone placed upon the posterior aspect of the head of the fibula, and from a powerful ligament which binds the upper part of this bone to the back of the external condyle of the femur; (2) by a tendinous slip attached to the outer aspect of the external condyle of the femur. The external popliteal nerve passes forwards between these slips of origin. The inner head, springs not only from the back of the internal condyle, but also from the whole breadth of the popliteal surface of the femur at the same level. The heads of the gastrocnemius join each other very shortly after their origin and the tendo achillis is inserted into the lower part of the posterior surface of the os calcis.

In the *Cuscus* the two heads of the gastrocnemius are separate throughout their entire length. The muscle therefore is present in the form of two distinct factors. The inner head (Pl. V. fig. 2, *b*) arises from the back of the internal condyle of the femur; it derives

[1] Ann. and Nat. Hist., vol. v., 4th series.

no fibres from the popliteal surface of the femur. Half-way down the leg, it gives place to a narrow tendon which has an independent insertion into the back of the os calcis (*b'*). The outer head has the same origin as in the *Thylacine*, with two exceptions, viz., (1) it has no tendinous slip attached to the outer aspect of the external condyle of the femur, and (2) it springs from the posterior aspect of the fibula in its upper two thirds through the medium of the intermuscular septum which intervenes between it and the peronei muscles. It is inserted by a strong tendon into the tuber of the os calcis, under cover of the tendon of the inner head (*a'*).

The fibular origin of the outer head of the gastrocnemius points very clearly to the fact that it is a compound muscle, and contains in its midst the fibres of the absent soleus. That the plantaris lies under cover of this muscle, is no proof against this view, and is certainly not evidence sufficient to lead one to look for the lost soleus amongst the deep muscles of the calf.[1] The plantaris is subjacent only to the inner part of the compound muscle, and does not lie under cover of the outer part which represents the soleus (Pl. V. fig. 2, *c*).

Plantaris.—In *Thylacinus* this muscle arises in common with the outer head of the gastrocnemius, and remains fused with its under surface for a considerable distance. It ends in a strong tendon which proceeds downwards along the inner side of the tendo achillis to the heel, where it expands, and, passing superficially to the tendo achillis, enters the sole. Here it spreads out in the form of a plantar fascia, which divides into three slips for the index, medius, and annularis. The plantar fascia is not attached to the subjacent muscles, and each of its terminal slips bifurcates to embrace the meta-tarso-phalangeal joint, and is attached to the ligamentous structures around this articulation.

In the *Cuscus* (Pl. V. fig. 2, *c*) the plantaris is a large muscle quite distinct from the soleo-gastrocnemius, although it lies under cover of its inner part. It arises from the sesamoid bone attached to the head of the fibula, and, passing over the tuber of the os calcis, it is inserted into a plate of cartilage in the sole which replaces the plantar fascia, and takes the place of the true heel.

This plantar cartilage (Pl. VI. fig. 5, *p.c.*) possesses very definite relations. Internally it is attached to a sesamoid bone which glides upon the internal cuneiform, and gives attachment to some of the short muscles of the hallux; externally it is fixed to the under surface of the cuboid, and here it gives origin to some of the short muscles of the minimus; posteriorly the plantaris tendon (*p.t.*) is inserted into it; whilst in front it is prolonged forward in the form of fascial slips, to the roots of the digits.

The plantaris is almost invariably present amongst the Marsupials. It is absent however in the Wombat.[2]

[1] Young, Muscular Anatomy of the Koala, p. 237, Jour. Anat. and Phys., vol. xvi.
[2] Macalister, *loc. cit.*, p. 3.

The deep muscles on the back of the leg show very material differences in the two animals.

Tibialis posticus.—In the *Thylacine* this muscle is small in size and intermediate in position between the flexor longus hallucis and the flexor longus digitorum. It has apparently no direct bony attachment at its origin, but springs from the fascia which covers the popliteus, whilst externally it is inseparably connected with the flexor longus hallucis. At the inner ankle its tendon passes under cover of that of the flexor longus digitorum, and proceeds along the inner margin of the foot to be inserted into the internal cuneiform bone, and into the base of the first metatarsal bone.

In the *Cuscus* the tibialis posticus is apparently double. The largest or internal part (Pl. V. fig. 2, *f*) occupies the position of the flexor longus digitorum which is absent. It arises by two heads—a tibial and a fibular. The latter springs from the posterior aspect of the head of the fibula, and its fibres which pass obliquely downwards and inwards are partially fused with the upper part of the subjacent popliteus. The tibial head takes origin from the upper half of the posterior surface of the tibia, and after being joined by the oblique fibular fibres, the muscle gives rise to a tendon which passes over a groove on the back of the internal maleolus to reach its insertion into the inner aspect of the scaphoid bone. It is possible that this muscle may be the representative of the flexor longus digitorum, but it is difficult to reconcile this view with its tarsal insertion.

The smaller and external part of the muscle (Pl. V. fig. 2, *g*) is a very minute fleshy belly, which lies deeply under shadow of the huge flexor muscle, and arises from the head of the fibula and the fascia over the popliteus. Its slender tendon passes over the groove on the back of the internal maleolus, under cover of the tendon of the preceding muscle, and is inserted into the plantar aspect of the scaphoid bone.[1]

Flexor muscles.—In the *Thylacine* there is a small flexor longus digitorum and a large flexor longus hallucis; in the *Cuscus* the flexor longus digitorum is apparently absent, but the flexor longus hallucis is a huge muscle, and it gives off from its superficial surface, whilst still in the leg, the representative of the flexor brevis digitorum.

The flexor longus digitorum in the *Thylacine* springs from the posterior aspect of the shaft of the tibia in its upper two-thirds, and also by a pointed and separate process from the back of the internal tuberosity of the tibia and the posterior ligament of the knee-joint. At the inner ankle it crosses the tendon of the tibialis posticus obliquely, and entering the sole ends by joining the large tendon of the flexor longus hallucis.

The flexor longus hallucis is a very large and powerful muscle. It occupies the outermost place of the deep muscles on the back of the leg, and it takes origin from the whole length of the posterior surface of the fibula. The thick rope-like tendon in which it ends enters the sole by passing forwards in a groove on the back of the astragalus, and after

[1] Young notes that the tibialis posticus is double in the Koala, *loc. cit.*, p. 41.

being joined by the tendon of the flexor longus digitorum, it splits into four, viz., a tendon for each toe.

In the *Thylacine* a small flexor brevis digitorum is found in the sole of the foot. It lies under cover of the expanded tendon of the plantaris, and springs from the inner aspect of the os calcis close to its posterior extremity. Four delicate tendons issue from it, and these pass downwards for a short distance in a groove on the superficial aspect of the large tendon of the flexor longus hallucis, and then diverge to reach their respective digits. The insertion of the flexor tendons upon the plantar face of the digits is effected in the usual manner.

We must now look at the arrangement of the huge flexor mass on the posterior aspect of the leg of the *Cuscus*. It occupies the place of the flexor longus hallucis, and arises from the whole length of the posterior aspect of the fibula as in the *Thylacine*, and also from the fascia covering the popliteus. About the middle of the leg it divides into two, viz., (1) a small superficial portion (Pl. V. fig. 2, *e*), and (2) a large deep part (Pl. V. fig. 2, *d*). These bear to each other very much the same relation that the flexor sublimis in the forearm of the same animal bears to the flexor profundus. The sublimis or superficial part ends in three tendons, and is the representative of the flexor brevis digitorum. It is interesting to note that it is supplied by a recurrent branch from the internal plantar nerve, whilst the profundus or deeper part is supplied by a twig from the internal popliteal nerve. The profundus ends in a rope-like tendon, which is grooved for the reception of the three delicate tendons of the flexor brevis digitorum. In the sole it divides into five tendons—one for each toe. The three tendons of the flexor brevis digitorum go to the minimus, annularis, and medius, and are pierced by the deep tendons.[1]

Lumbricales.—In the *Cuscus* these are four in number, and with the exception of that for the index they are very large, and expand so much towards their insertions that their attachment extends along the whole length of the first phalanx. Pl. III. fig. 1, *l*. shows the lumbrical of the annular digit.

In the *Thylacine* the lumbrical muscles are peculiar. Each muscle is double, so that one arises from each side of the deep flexor tendon and envelopes it completely in sparse muscular fibres. Again, they are not inserted into the dorsal extensor expansion but are attached to the flexor sheaths of the digits—two to each toe.

Popliteus (pronator tibiæ).—This muscle consists of a continuous layer of oblique fibres which occupies the entire interosseous space. It is thick and fleshy in its upper and lower thirds, but its middle third is very thin, and has a large admixture of tendinous fibres entering into its composition. The fibres of the muscle pass from the fibula obliquely downwards and inwards to the tibia.

In the *Cuscus*, in which the interspace between the bones is wide and the movement of the fibula peculiarly free, the attachment of the muscle in different planes (so well

[1] There is no musculus accessorius in the foot of either *Thylacinus* or *Cuscus*.

described by Dr. Young in the Koala[1]) is very evident. The upper thick fleshy mass is fixed on the one hand to the posterior surface of the tibia and on the other to the antero-internal border of the fibula. A few very oblique and superficial fibres arising from the external lateral ligament of the knee-joint evidently represent the popliteus proper, the rest of the muscle being the pronator tibiæ of Humphry. The lower thickening of the muscle is fixed to the antero-external surface of the tibia.

The movements of the fibula upon the tibia at the tibio-fibular joints cannot in any respect be compared to those of pronation and supination in the forearm. Young, in his admirable paper upon The so-called Movements of Pronation and Supination in the hind-limb of certain Marsupials,[1] has already pointed out that the "tibio-fibular articulations admit of movements in the antero-posterior directions only; these movements are simply those of gliding and coaptation." He also shows how the attachment of the interosseous muscle on different planes affects this movement; the upper portion of the muscle producing "a backward and inward movement of the upper end of the fibula," whilst the lower fibres by their contraction draw the lower end of the bone inwards and forwards, or in other words, when the whole muscle contracts, the fibula is "thrown obliquely across the tibia" and approximated to it. From a study of the pronator tibiæ muscle, and the tibio-fibular articulations in the *Cuscus*, I can verify Dr. Young's results.

In the *Thylacine* the movement of the fibula upon the tibia is extremely limited, but of precisely the same character as in the *Cuscus*. The pronator tibiæ muscle is, however, very well developed, but owing to the close apposition of the bones, the fibres are exceedingly short. It shows the same thickening in its upper and lower portions, and below it is chiefly seen from the anterior aspect of the limb, owing to the tibial attachment of the fibres being so far forward upon the bone.

As in the Koala, the tibia and fibula in the *Cuscus* are separated at the lower tibio-fibular articulation by a fibro-cartilage, which juts upwards between them from the ankle-joint. In *Thylacinus*, however, the lower ends of the bones are in direct apposition, and both surfaces are coated with encrusting cartilage.

Anterior and Outer Aspects of the Leg.

In the *Cuscus* there are three well-defined muscles upon the anterior aspect of the leg, viz., the tibialis anticus, the extensor longus hallucis, and the extensor longus digitorum. These muscles occupy the same relative position as in man. In *Thylacinus* the extensor longus hallucis is absent.

Tibialis anticus (Pl. V. fig. 3, *f*).—This is a very powerful muscle in both animals; it

[1] Jour. Anat. and Phys., vol. xv. p. 393.

springs from the outer tuberosity and the outer surface of the shaft of the tibia and from the interosseous membrane. In the *Cuscus* it is inserted into the plantar aspect of the internal cuneiform bone and the base of the first metatarsal bone; in the *Thylacine* it is inserted into the base of the metatarsal bone of the index.

Extensor longus hallucis (Pl. V. fig. 3, g').—This is present only in *Cuscus*, and is a well-developed muscle, which lies almost completely under cover of the extensor longus digitorum. It arises from the anterior prominence of the head of the fibula, from the inner border of the fibula in its upper half and from the interosseous membrane. It makes its appearance by passing forwards between the tibialis anticus and the extensor longus digitorum, and its tendon is inserted into the ungual phalanx of the hallux. In some Marsupials, according to Professor Macalister,[1] this muscle is inserted by two tendons into the hallux and index, viz., Wallaby, Oppossum, *Phalanger*.

Extensor longus digitorum (Pl. V. fig. 3, *e*).—In the *Cuscus* this muscle has a very limited origin from the anterior prominence of the head of the fibula, from the outer tuberosity of the tibia, and from a ligament which bridges across between these two bony projections. In the *Thylacine* its orgin is much more extensive, viz., from the anterior aspect of the head of the fibula, from the inner surface of the same bone in its upper two thirds, and also from a corresponding portion of the interosseous membrane.

In the *Cuscus* the muscle ends in three tendons. Of these one (the intermediate) goes to the ring digit, the outermost to the little toe, whilst the innermost divides into two for the index and medius. Each of the lateral tendons sends a slip to strengthen that for the large ring digit.

In the *Thylacine* four tendons are given off by the extensor communis digitorum, and these are inserted in the following manner:—(1) The outermost is inserted into the minimus, (2) the second (counting from the outer margin of the foot) divides and sends a slip to the annularis and medius, (3) the third also divides for the medius and index, (4) whilst the fourth goes to the index alone.

Peroneal muscles—This group of muscles comprises in each case (1) the peroneus longus, (2) the peroneus brevis, and (3) certain fleshy slips which represent portions of the extensor brevis digitorum.

Peroneus longus.—This is a very powerful muscle in the *Cuscus* (Pl. V. fig. 3, a^1 and a^2), in the *Thylacine* it is not so strongly developed. In both it springs by two heads which are separated from each other by the anterior tibial nerve. In *Cuscus* the one head of the peroneus longus, a broad flat band, is superficial to the other, and springs from the anterior and posterior prominences on the head of the fibula and from the external lateral ligament of the knee-joint; the deep head arises from the outer aspect of the shaft of the fibula in its upper half. A strong tendon (Pl. V. fig. 3, a') issues from the muscle; this passes downwards behind the external maleolus to the outer margin of the foot, where

[1] *Loc. cit.*, p. 3.

it turns round a deep groove in the cuboid, and is directed inwards across the sole. It is inserted into the base of the first metatarsal bone. Two annular ligaments confine the tendon in its passage downwards, viz., behind the external maleolus and upon the outer aspect of the os calcis. In the sole of the foot it is not provided with a complete sheath.

In *Thylacinus* the peroneus longus presents an origin very similar to that in *Cuscus*. Its tendon, however, is inserted into the ento-cuneiform bone, and as it winds round the outer margin of the foot it is slightly attached by tendinous fibres to the base of the fifth metatarsal bone.

Dr. Georg Ruge,[1] in his elaborate memoir upon the extensor muscles of the leg and foot, expresses his belief that the insertion of the peroneus longus into the inner margin of the foot does not present the original condition of the muscle. To explain the course of the tendon across the sole of the foot he advances the hypothesis that the original insertion of the tendon was into the base of the fifth metatarsal, and that its progress inwards has been caused by the fibres of insertion coming more and more into relation with the plantar ligaments. In support of this theory he points to the *Monotremata*, in which the tendon does not lie free in a sheath during its passage through the sole, but is connected by thin membranous slips to the cuneiform bones, and in which also the tendon is attached by a process containing half its fibres to the base of the fifth metatarsal. In the *Didelphys virginiania*, *Didelphys cancrivora*, and the *Dasyurus hallucinatus* he likewise noticed an attachment of the tendon of the peroneus longus to the tuberosity on the base of the fifth metatarsal bone, whilst in the first of these animals it presented additional attachments to the bases of the third and fourth metatarsal bones.

In *Cuscus* the tendon (Pl. VI. fig. 6, *p.t.*) lies quite free in its sheath, and has no other attachment except to the base of the first metatarsal bone; in *Thylacinus*, as we have seen, it is slightly attached to the base of the fifth metatarsal bone.

Peroneus brevis.—In the *Cuscus* (Pl. V. fig. 3, *b*) this muscle arises by a narrow pointed tendon from the anterior prominence of the head of the fibula; it likewise derives fibres from the intermuscular septum between it and the extensor communis digitorum. In the *Thylacinus* it also takes origin from the shaft of the fibula in its upper half, and in both animals it is inserted into the base of the fifth metatarsal by a tendon which runs downwards behind the external maleolus and then along the outer margin of the foot.

It seems to be the rule for this muscle to take origin from the shaft of the fibula as in the *Thylacine*. Ruge[1] describes this in the *Didelphys virginiana*, *Didelphys cancrivora*, and in *Dasyurus hallucinatus*. Dr. Ruge believes that the peroneus brevis is originally derived from the outermost belly of the extensor brevis digitorum.

[1] A Research into the Group of Extensors of the Leg and Foot of Mammalia, Morph. Jahr., 1880.

Extensor brevis digitorum.—In the memoir by Ruge, to which reference has been made, the author traces with great ability the history of this muscle. It belongs originally to the peroneal group of muscles, and in the *Monotremata* it may be observed to arise entirely from the fibula. Its progress as it passes down to the dorsum of the foot can be traced step by step through the mammalian series. First one belly descends, then another, and so on until the entire muscle gains the dorsum of the foot, as in man.

In *Thylacinus* the entire muscle arises from the fibula ; in the *Cuscus* the part belonging to the medius and index has reached the dorsum of the foot, whilst that belonging to the two outer digits still shows a fibular origin.

In the *Thylacine* the extensor brevis digitorum is represented by three separate fleshy bellies, all of which arise from the fibula under cover of the two peronei muscles. The largest of these fleshy bellies springs from the upper third of the fibular shaft, and its tendon joins the dorsal expansion of the extensor tendon of the little toe ; the other two arise side by side from the middle third of the fibular shaft, and of these the posterior belly gives rise to a tendon which divides to reach the extensor expansions of the index and middle digits, whilst the anterior belly sends its tendon to the extensor expansion of the ring toe. All these tendons accompany the tendons of the peronei muscles behind the external malleolus.

In the *Cuscus* the fibular portions of the extensor brevis digitorum are two in number, viz., (1) a good sized muscle (Pl. V. fig. 3, *c*.) which arises from the outer aspect of the head of the fibula, under cover of the superficial head of the peroneus longus ; the slender tendon of this fleshy slip passes behind the external malleolus, and is inserted into the dorsal expansion of the extensor tendon of the minimus (*c'*.) ; (2) the second fleshy belly (Pl. V. fig. 3, *d*) is subjacent to the preceding, and springs from the middle third of the inner aspect of the shaft of the fibula ; its tendon passes behind the external malleolus and gaining the dorsum of the foot is inserted into the extensor expansion of the ring digit (*d'*.)

The pedal portion of the extensor brevis digitorum in the *Cuscus* (Pl. V. fig. 3, *h*) arises by a narrow tendon from the outer aspect of the os calcis. It is a very minute fleshy band, which ends in two delicate tendons for the index and medius respectively.

In the Koala[1] the arrangement of the extensor brevis digitorum is similar to that of the same muscle in the *Cuscus*.

According to Ruge[2] the fibular portion of the muscle in *Didelphys* and *Dasyurus* consists of two fleshy bellies, of which one sends a tendon to the fifth toe, whilst the other supplies tendons to the second, third, and fourth toes; further, in *Didelphys* there is a pedal portion which is devoted solely to the hallux and index.

[1] Young, *loc. cit.*, p. 41. [2] *Loc. cit.*, p. 46.

INTRINSIC MUSCLES OF THE MAMMALIAN FOOT.

We have seen that the intrinsic muscles of the manus of certain of the Marsupialia (*vide* p. 19) may be considered to be disposed in three layers according to the plane which they occupy as we dissect from the palmar to the dorsal aspect of the hand. Each digit is provided with three muscles, each of which exercises its own independent action upon it. It derives an adductor from the palmar layer, an abductor from the dorsal layer, and a flexor brevis from the intermediate layer. The medius is usually an exception to this rule, inasmuch as two of its muscles belong to the dorsal layer.

In making inquiry into the arrangement of the corresponding muscles of the pes, I have extended my investigations over a much wider area. In the case of the manus my observations, with a very few exceptions, were restricted to members of the Marsupial order; in the case of the pes I have examined a large number of different mammalian feet, and with very interesting results. From the Challenger Expedition Commission I received for this purpose one specimen of each of the following animals:—(1) the Dingo or Australian Wild Dog, (2) *Hyrax capensis*, (3) *Ornithorhynchus paradoxus*, (4) *Mus capensis*, (5) *Bathyergus capensis*, (6) *Felis concolor*. The other specimens which I have had an opportunity of examining were for the most part supplied from the stores of the Anatomical Museum of the Edinburgh University, which Professor Turner, with his usual kindness, placed at my disposal.

Definition of the term "intrinsic."—The term "intrinsic" as applied to the muscles of the foot can best be defined by a process of exclusion—by naming those muscles which it does not include. These are—

1. The accessorius and lumbricales. 2. The flexor brevis digitorum.
3. The extensor brevis digitorum.

The accessorius and lumbricales cannot be regarded as independent muscles. They are simple accessory parts of the flexor longus digitorum and must therefore be classed with it. The flexor brevis digitorum is the homologue of the flexor sublimis of the forearm, and in some animals it may be seen taking origin beyond the limits of the foot in common with the flexor longus digitorum. The extensor brevis digitorum is excluded for the same reason. The history of this muscle has already been referred to (p. 47). Originally a peroneal muscle, it comes to lie in a number of animals upon the dorsum of the foot.

In the human foot, therefore, the intrinsic muscles are the following:—

a. The four short muscles of the great toe,
1. Flexor brevis hallucis.
2. Abductor hallucis.
3. Adductor hallucis (adductor obliquus).
4. Transversalis pedis (adductor transversus).

b. The short muscles of the little toe, . .
   1. Flexor brevis minimi digiti.
   2. Abductor minimi digiti.
   3. The occasional opponens minimi digiti.
   4. The occasional abductor ossis metatarsi minimi digiti.

c. The interossei, . . .
   1. Four dorsal.
   2. Three plantar.

The determination of muscle homologies.—In tracing the history of any muscle or group of muscles the characters upon which most dependence is to be placed are clearly: (1) the position, (2) the insertion, (3) the nerve supply. Not one of these, however, can be looked upon as an infallible guide. The insertion, inasmuch as it involves the action or function of a muscle more than the origin, is of considerably greater importance. The origin, and in a corresponding measure, the position of a muscle are changeable features upon which we cannot place much reliance. The best example which can be given of this is the descent of the different bellies of the extensor brevis digitorum from the fibular aspect of the leg to the dorsum of the foot. Still in the group of muscles with which we have to deal instances of the same kind are by no means infrequent. Thus the marginal intrinsic muscles of the foot (*i.e.*, the abductor minimi digiti and abductor hallucis) show an invariable tendency to extend backwards to the os calcis for their origin, and, when the hallux or minimus is absent, the dorsal interosseus which thus becomes marginal commonly exhibits a like tendency unless it be confined by a rudimentary metatarsal. The adductors perhaps more than any other members of the intrinsic group tend to shift their origin according to the requirements demanded of them. The character of these changes will be fully discussed later on.

Dr. Georg Ruge of Heidelberg insists strongly upon the invariable and immutable relationship between nerve supply and muscle homology. He asserts with Gegenbaur that a muscle is to be regarded as the end-organ of a nerve, and therefore when a muscle alters in position and connections its original and typical relations can always be identified by its nerve of supply.[1] That this is a most valuable aid in our endeavours to discover the history of a muscle no one will deny; but that it is an infallible guide is a view which is contrary to fact. We shall afterwards have occasion to refer to this.

Recognising, then, the importance of the nerve supply as a guide in the determination of muscle homology, I have, in the present inquiry, examined the plantar nerves in connection with the muscles in as many cases as it was possible to do so.

In the human foot we find that the abductor hallucis and the flexor brevis hallucis are supplied by the internal plantar nerve, whilst all the other intrinsic muscles receive their nerve supply from the external plantar nerve. The second and first dorsal interossei sometimes receive additional nerve fibres from the anterior tibial nerve on the

[1] Processes in the Development of the Muscles of the Human Foot, Morphologisches Jahrbuch, 1878, p. 137.

dorsum of the foot.[1] Ruge accounts for this peculiarity by looking upon the second and first interosseous muscles in these cases as being compound muscles,—receiving accessory heads from the extensor brevis digitorum. The nerve filaments which go to them, from the anterior tibial, are therefore for the supply of these extraneous fibres.[2]

Conclusions Regarding the Dispositions of the Intrinsic Muscles.

I. That the typical arrangement of the intrinsic muscles of the pes is the same as in the hand, and that this arrangement is seen to best advantage in the feet of certain of the Marsupialia. In these animals the muscles are disposed in three layers :—

1. A plantar layer of adductores.
2. An intermediate layer of flexores breves.
3. A dorsal layer of abductores.[3]

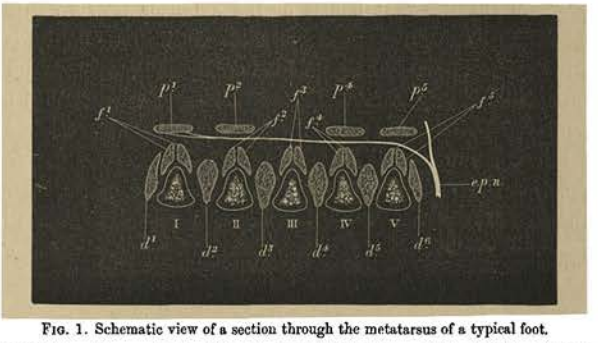


Fig. 1. Schematic view of a section through the metatarsus of a typical foot.
(I. to V.) Metatarsal bones. (p^1 to p^5) Plantar layer of adductores. (f^1 to f^5) Intermediate layer of flexores breves. (d^1 to d^6) Dorsal layer of abductores. (*e.p.n.*) External plantar nerve.

Deviations from this typical trilaminar disposition may take place—(*a*) by subdivision of certain of the members of one or other of the layers, (*b*) by fusion of certain of the elements of the different strata, or (*c*) by suppression or non-development of some of the muscles.

The first of these deviations is to be found in a few Marsupial animals, in which a tendency is exhibited to the development of a fourth layer of muscles by the splitting

[1] Rudinger Die Gelenknerven des Menschlichen Körpers, Erlangen, 1857. Cunningham, Journal of Anatomy and Physiology, vol. xiii.

[2] *Loc. cit.*, p. 50.

[3] Professor Humphry, in his Memoir upon the Myology of the *Orycteropus capensis* (Jour. of Anat. and Phys., May 1868), alludes in a footnote to this typical arrangement, and singles out the Rabbit as affording a good example. In this animal, however, the dorsal and intermediate muscles have undergone fusion, and it does not exhibit the trilaminar disposition so well as the marsupial hand or foot.

of the dorsal interossei. Fusion of the constituents of the intermediate and dorsal layers is extremely common, whilst fusion between the plantar and intermediate muscles is a very rare occurrence. Suppression of certain of the muscles may take place in two ways. It may either be complete—not a trace of the lost muscle being left—or partial, in which case the place of the missing muscular belly is taken by a ligamentous structure, having the same connections, and probably a distinct function to play in the mechanism of the foot.

II. The presence of an opponens muscle is not accounted for in the foregoing disposition of the intrinsic muscles. When present, it may be regarded as being derived from one or two sources. Most commonly it is a development from the flexor brevis, but it may proceed, as in many of the Carnivora, from the plantar layer, and thus be associated with the adductors.

III. The last point which I am anxious to prove is, that in many animals, the relation of the intrinsic muscles to the metatarsal bones, both as regards their origin and position, corresponds with transitory conditions in the foot of the human embryo.

Let us take up the first of these generalisations, and examine the facts upon which it is founded.

Marsupialia.

Thylacine (Pl. VI. figs. 1, 2).

The pes of this animal closely resembles that of the Dog. The hallux is suppressed, but in connection with the remaining four digits the typical disposition of the intrinsic muscles in three layers is very manifest.

The plantar layer (p^2, p^4, p^5) consists of three muscles, which have as their function the adduction of the toes, towards a line drawn through the medius. They are—

1. Adductor indicis (p^2).
2. Adductor annularis (p^4).
3. Adductor minimi digiti (p^5).

The adductor indicis and the adductor minimi digiti arise in the middle line of the foot by a single pointed origin from the fibrous structures at the base of the metatarsus. Separating and then diverging from each other the former is inserted upon the fibular side of the base of the proximal phalanx of the index, whilst the latter is inserted upon the tibial side of the base of the corresponding phalanx of the minimus. In both cases the insertion is partly into the sesamoid bone, and partly into the extensor tendon on the dorsum of the digit. In some cases the adductor indicis is double (*vide* fig. 1).

The adductor annularis springs from the base of the middle metatarsal, under cover of the two preceding muscles, and swelling out into a fusiform belly, it is inserted upon the tibial side of the proximal phalanx of the annular digit in a manner similar to the other adductor muscles.

Intermediate layer (f^2 to f^5).—The muscles composing this layer are four in number, and are placed one upon the plantar surface of each metatarsal bone, but further, each muscle consists of two slips, which may arise separately, or by a common origin from the base of the metatarsal bone with which they are associated. No definite rule seems to apply to their mode of origin. In the feet of the same animal the muscle of any given digit may be seen arising in the one pes by two heads, whilst in the other it may take origin by a single head. At the root of the toe the two slips embrace the base of the proximal phalanx, and are inserted one into each sesamoid bone, and sometimes also into the extensor tendon as well.

These muscles, then, are true flexores breves when the two slips act in unison. When they act independently of each other, however, they exercise an abducting or adducting influence, according to the slip employed.

The *dorsal layer* (d^2 to d^6) includes the abductor minimi digiti, the abductor ossis metatarsi minimi digiti, and the four dorsal interossei.

The abductor minimi digiti ($d^{6\prime}$) is a small fleshy slip which arises from the outer aspect of the tuberosity of the os calcis, and soon ends in a long narrow tendon. This is inserted into the extensor tendon of the minimus on the fibular side of the first phalanx.

In the foot of the large male *Thylacine* an additional abductor of the little toe was present. This consisted in an exceedingly minute fasciculus ($d^{6\prime\prime}$), which took origin from the base of the metatarsal, and extended downwards upon the surface of the outer head of the flexor brevis to its insertion into the outer sesamoid bone.

The abductor ossis metatarsi minimi digiti (d^6) is a strongly marked muscle which springs from the outer aspect of the tuberosity of the os calcis in common with the abductor minimi digiti. It presents the usual insertion into the base of the fifth metatarsal bone.

The splitting up of the abductor of the little toe into three parts points to the usual triple insertion of this muscle (viz., into the metatarsal bone, into the sesamoid bone, and into the dorsal expansion of the extensor tendon), and indicates a tendency for the fibres belonging to each of these insertions to separate and constitute a distinct muscle. The abductor metatarsi is very constant throughout the mammalian series, but it is rare to find the other two parts separate. In the *Cuscus*, however, it is even more evident than in the *Thylacine*.

The dorsal interossei.—The first dorsal interosseus or abductor indicis, owing to the absence of the hallux, is marginal in its position, and therefore more highly developed than the others. It consists of two parts (fig. 2, d^2, and $d^{2\prime}$). Of these one arises from the base of the metatarsal, in common with the inner head of the flexor brevis indicis, and is inserted into the inner sesamoid bone; the other wanders backwards for its origin (thus exhibiting the usual tendency of a marginal muscle), and springing from the scaphoid is inserted into the extensor tendon on the inner aspect of the index.

The remaining three dorsal interossei (fig. 2, d^3 to d^5) cannot be properly studied unless we throw forward both the plantar and intermediate muscles. They are then seen to be prismatic, one-headed muscles, lying in the interosseous spaces, but only reaching for a short distance upwards between the bones; indeed they are more plantar than dorsal in their relation to the metatarsus. They spring from the bases of the metatarsal bones, and are inserted so as to abduct the toes from a line drawn through the medius. The second and third, therefore, are appropriated by the medius, whilst the fourth is set aside for the annularis. They correspond, therefore, in their insertions with the same muscles in the human hand.[1]

Dasyurus viverrinus (Pl. XI. figs. 5–6).

The foot of this animal is long and narrow. The hallux is very rudimentary, consisting merely of a short metatarsal, which is only evident in the undissected condition of the pes as a slight protuberance on its inner margin. The other four digits are well developed, and of nearly equal length.[2] The metatarsal bones are placed in such close apposition that when the foot is viewed from its dorsal aspect, not a single intrinsic muscle is apparent. They are all crowded into the sole, but, in spite of this, they exhibit in a marked manner the typical trilaminar disposition, each of the four well-developed toes being provided with three separate intrinsic muscles.

Plantar layer (fig. 5, p^1 to p^5).—In this layer we find four muscles which act so as to draw the digits into which they are inserted towards a line drawn through the medius. They are—

1. Adductor hallucis (p^1).
2. Adductor indicis (p^2).
3. Adductor annularis (p^4).
4. Adductor minimi digiti (p^5).

The adductor indicis and adductor minimi digiti are the most strongly marked. They together constitute an exceedingly thin triangular sheet of fibres which lies superficial to the other muscles. This muscular sheet takes origin by its apex which is tendinous, in the middle line of the foot, from the ligaments which bind the metatarsus to the tarsus. Its base arches over the bases of the annularis and medius, and it is inserted by its angles into the index and minimus—in the case of the former into the outer sesamoid bone at its base, and in the case of the latter, into the inner sesamoid bone. The separation of the two muscles is indicated by a faint fibrous raphe which traverses the triangular muscular sheet from the apex to the centre of its arched base.

The adductor annularis is a minute fusiform fleshy slip which arises from the deep surface of the raphe which separates the two preceding muscles. The muscular sheet com-

[1] In the feet of the small female *Thylacine* a slight tendency to fusion between the flexores breves, and the dorsal interossei was exhibited. In the large male, however, they were quite distinct.

[2] In Waterhouse's well-known work upon Mammalia, an excellent figure of this foot is given in vol. i. pl. xii. fig 1.

posing these muscles is so thin that this small fasciculus can be seen shining through the fibres. Emerging from under cover of the arched lower border of the combined muscles it is inserted into the inner sesamoid bone at the base of the proximal phalanx of the annularis.

The adductor hallucis is a delicate little muscle which springs from the base of the metatarsus, close to the inner side of the conjoined origin of the adductors of the index and minimus. It is inserted into the outer side of the head of the metatarsal bone of the rudimentary hallux.

In a recent paper by Ruge,[1] upon the comparative anatomy of the deep muscles of the sole of the foot, the author describes and figures in the *Dasyurus hallucatus*, a special adductor of the medius. This muscle does not exist in the foot of the *Dasyurus viverrinus*, and its presence in the specimen which Dr. Ruge dissected is somewhat difficult to understand, seeing that it is rare for the digit which constitutes the centre for the movements of adduction and abduction to be supplied with a special adductor. Ruge considers it to be a link which binds this animal with the *Ornithorhynchus paradoxus*, the pedal muscles of which have a very remarkable arrangement.

Intermediate layer (fig. 6, f^1 to f^5).—Very little need be said regarding the muscles which compose this layer. Each of the four outer toes is provided with a flexor brevis, which is quite distinct from the dorsal interossei, and shows no tendency to fuse with them, notwithstanding their close proximity, from the more or less complete obliteration of the inter-metatarsal spaces. Each muscle arises from the base of the metatarsal bone upon which it lies, and soon divides into two slips. These embrace the root of the corresponding toe, and are inserted one into each sesamoid bone. The flexores breves are very similar, therefore, to the same muscles in *Thylacinus*—differing only in the two heads of each muscles springing in all cases by a common origin.

In addition to the adductor hallucis, the rudimentary hallux is provided with a small fleshy slip (figs. 5 and 6, f^1t), which arises from the scaphoid, and is inserted into the inner side of the head of the metatarsal bone. The question naturally arises—What is this muscle? Is it a flexor brevis or an abductor? It is supplied by the internal plantar nerve, but this does not help us in our difficulty, seeing that both these muscles usually derive their nerve fibres from this source. Ruge apparently considers it to be the abductor hallucis, as he marks it in the figure of the foot of the *Dasyurus hallucatus* (*a.h.*), but I think it is more likely that it represents both muscles fused into one. My reason for this belief is, that in *Phascogale*, in which the hallux is slightly better developed, the two muscles are distinct from each other although in very close proximity.

The *dorsal layer* consists of—(1) the abductor ossis metatarsi minimi digiti ($d^{6\times}$), (2) two abductors of the little toe (d^6 and $d^{6'}$), (3) four dorsal interossei (figs 5 and 6, d^2 to d^5).

The abductors of the little toe are three in number, and arranged in a manner very similar to those of the *Thylacine*. The muscle which is inserted into the sesamoid ($d^{6'}$)

[1] Dr. Georg Ruge, Zur vergleichenden Anatomie der teifen Muskeln in der Fussohle, Morph. Jahrbuch, 1879.

takes origin further back, however, from the under surface of the projecting base of the fifth metatarsal bone. It is a very minute although perfectly distinct slip, and it is rendered all the more apparent from the fact that the deep division of the external plantar nerve (*d*), as it turns inwards, passes under cover of it. In *Dasyurus hallucatus* Ruge[1] both figures and describes this slip with great exactitude. In his specimen, however, it did not attain an independent insertion, but blended with the outer head of the flexor brevis.

The four dorsal interossei are plantar in position. They are one-headed muscles which arise from the bases of the four outer metatarsal bones, and are inserted as in *Thylacinus*, so as to abduct the digits from a line drawn through the medius. This digit, therefore, is supplied with two, viz., the second and third.

Phascogale calura.

The foot of this animal in external characters closely resembles that of the *Dasyurus viverrinus*. The hallux, however, is more strongly developed; still it is not furnished with a nail or claw, nor is it nearly so long as the other four digits.[2] The metatarsals are placed so close to each other that all the intrinsic muscles are situated in the sole. The trilaminar arrangement is nevertheless very manifest.

Plantar layer.—This layer is composed of four muscles, all of which lie upon one plane. They are—

1. Adductor hallucis.
2. Adductor annularis.
3. Adductor indicis.
4. Adductor minimi digiti.

These muscles are inserted so as to adduct the digits with which they are connected towards the medius.

The adductor indicis, adductor annularis, and adductor minimi digiti all spring by a common tendinous origin from the base of the metatarsus in the middle line of the foot. This soon expands into a thin fleshy sheet which lies upon the other intrinsic muscles. Near the roots of the toes it divides into three slips which diverge from each other to reach their respective points of insertion.

The adductor hallucis has an independent origin from the base of the metatarsus, upon the inner side of the common tendon of the other three adductors. It is inserted into the outer aspect of the first phalanx of the hallux.

Intermediate layer.—The four outer toes are each provided with a double-headed flexor brevis, and these muscles have an arrangement similar in every respect to that of the corresponding muscles in *Dasyurus*.

The hallux also is furnished with a flexor brevis, which in this case is quite distinct from the abductor. The inner or tibial head, however, alone is present.

Dorsal layer.—In this layer we find (1) the abductor ossis metatarsi minimi digiti,

[1] *Loc cit.*, p. 54.

[2] In Waterhouse's Mammalia a figure of the foot of *Phascogale penicillata* is given (pl. xii. vol. i.).

which has precisely the same connections as in the two preceding animals; (2) the abductor minimi digiti, which in this case is single; (3) four dorsal interossei, which are arranged similarly to the corresponding muscles in *Dasyurus;* (4) the abductor hallucis, which arises from the base of the first metatarsal bone, and is inserted into the outer side of the base of the proximal phalanx. It lies in close contact with the flexor brevis hallucis, but is easily separable from it.

Cuscus maculata (Pl. V. fig. 1, and Pl. VI. figs. 5, 6).

The foot of this animal in the undissected state is seen in Plate V. fig. 1. The hallux is a broad powerful digit placed at right angles to the long axis of the foot, so as to oppose the other toes. It is not furnished with a claw, and is curved somewhat towards the sole. The index and medius are poorly developed, and are enveloped in a common integumental covering as far down as the second phalangeal joints. Independent movement of these digits, therefore, is rendered impossible. Of the four outer toes the annularis is much the largest. In every respect this foot is admirably adapted for grasping the boughs of the trees in which the animal passes its existence.

The position of the hallux, so far apart from the other toes, somewhat disconcerts the typical arrrangement of the muscles in so far as this digit is concerned. Still, sufficient indications remain to justify the conclusion that its three muscles, viz., the abductor, flexor brevis, and adductor belong one to each of the three layers that are here laid down as typical.

The *plantar layer* (fig. 5 p^1 to p^5) consists of three muscles, viz.:—

1. Adductor hallucis (p^1).
2. Adductor minimi digiti (p^5).
3. Adductor annularis (p^4).

The adducting muscles of both manus and pes of all animals show a strong tendency to place themselves obliquely or even at right angles to the digit upon which they operate. In this manner they obtain a more powerful adducting influence. In the feet of the *Thylacine, Dasyurus,* and *Phascogale* we have seen these muscles seek the middle line for their origin, and from this they radiate towards their insertions. In *Phascogale* they all lie upon the same plane, but in *Thylacinus* and *Dasyurus* the adductors of the index and minimus in pressing inwards, have thrust the adductor of the annularis upwards, and have thus come to coalesce and lie superficial to it (*vide* Pl. VI. fig. 1, and Pl. XI. fig. 5). Again, in the human foot we see the transversus pedis placing itself at right angles, and the adductor hallucis obliquely in relation to the great toe. But still more striking examples are to be observed in the hand and more especially in the foot of the *Cuscus.* In the hand the adductors arise from a median fibrous raphe placed over the middle metacarpal bone. In the foot, adduction is effected towards a line drawn through the index, and the raphe is placed over the metatarsal bone which belongs to this digit (fig. 5, *r.*).

There is no adductor of the index in the *Cuscus*. The fibrous raphe (fig. 5, *r*.) is attached to the outer aspect of the base of its proximal phalanx, and the lower end of this probably represents the missing muscle, which has thus been converted into fibrous tissue.

The adductor hallucis (fig. 5 p^1) is the most powerful of the three muscles of the hallux, and at the same time it is the most complex in its arrangement. It has a double origin—(*a*) from the base of the metatarsal bone of the index, and from the tibial side of the fibrous raphe; (*b*) by a few fibres from the aponeurosis which clothes the dorsal aspect of the first dorsal interosseous muscle. The fleshy fibres soon arrange themselves into three slips which we may distinguish by the terms plantar, intermediate, and dorsal, and by these it is inserted. The plantar slip is attached to the outer of the two sesamoid bones along with the outer head of the flexor brevis hallucis. The intermediate slip ends in a long delicate tendon, and is inserted by this into the fibular side of the minute distal phalanx, and the dorsal portion ends in the extensor tendon.

The adductor minimi digiti (fig. 5, p^5) is a fan-shaped muscle which arises by its base not only from the greater extent of the fibular margin of the fibrous raphe but also from the ligamentous textures at the base of the third and fourth metatarsal bones. From this its fibres converge, and it is inserted into the tibial side of the base of the proximal phalanx of the minimus.

The adductor annularis (fig. 5, p^4) is small in comparison with the preceding muscle, but it has the same triangular shape, and it is placed at right angles to the toe upon which it operates. It arises from the fibular margin of the distal portion of the raphe, and also from the base of the first phalanx of the index. Arching over the base of the medius, it is inserted into the tibial side of the base of the proximal phalanx of the annularis.

The line towards which these muscles adduct the toes is manifestly one drawn through the index, and this, whilst it corresponds with the human foot, is an exception to the general rule that abduction and adduction are effected with reference to a line drawn through the medius.

The intermediate layer (figs. 5, 6, f^1 to f^5).—There are five muscles composing this layer, one to each toe, and they correspond with the same muscles in the preceding animals. Each muscle consists of two slips, and these are inserted one into each sesamoid bone at the base of the digit with which they are associated.

The flexor brevis hallucis (f^1) is one of this group, but owing to the position of the hallux it is somewhat separated from its neighbours. It arises by a single tendinous origin from the under surface of the scaphoid, and dividing into two heads it is inserted by these into the sesamoid bones at the base of the proximal phalanx of the hallux. The tibial insertion is associated with that of the abductor hallucis, and the fibular with that of the plantar part of the adductor hallucis.

The dorsal layer (fig. 6, d^1 to d^6).—This group includes (1) the abductor hallucis;

(2) two divisions of the abductor minimi digiti; (3) the abductor ossis metatarsi minimi digiti; (4) the dorsal interossei.

The abductor hallucis (fig. 5, d^1) is a strong muscle, which arises from the cartilage of the sole, and a sesamoid bone which glides upon the plantar surface of the scaphoid. Its chief insertion is by fleshy fibres into the tibial sesamoid bone of the hallux, but it is also prolonged onwards by a slender tendon to the tibial side of the distal phalanx. By a third slip it gains an insertion into the extensor tendon.

The three abductors of the little toe (fig. 5, d^6 $d^{6'}$ $d^{6''}$) arise side by side from the outer and under surface of the tuber of the os calcis. They are inserted into the base of the metatarsal bone, into the outer sesamoid bone, and into the extensor tendon. The abducting apparatus on the outer aspect of the foot of the *Cuscus*, therefore, is more differentiated than in any of the preceding animals. In the *Thylacine*, a separate slip for the sesamoid is only an occasional occurrence; it is always very feeble, and springs from the base of the metatarsal. In *Dasyurus* it seems to be constant, and it arises further back in the foot. In *Cuscus* it reaches its full development, and arises from the os calcis with its neighbours.

The dorsal interossei are placed more in the sole than the corresponding muscles of the hand. They are not bipenniform, and they show a slight tendency to fuse with the flexores breves.

The first or abductor indicis (fig. 6, d^2) is the most powerful of the series. It arises by two heads—(*a*) from the internal cuneiform (*b*) from the base of the first metatarsal, and it is inserted into the tibial side of the base of the proximal phalanx of the index, and also into the extensor tendon. The index and medius, as we have seen, have no independent power of movement as they are enclosed within the same integumental covering; they constitute, in fact, from a functional point of view, one digit. In consequence of this, the second dorsal interosseous muscle is so completely amalgamated with the inner head of the flexor brevis medii that its presence cannot be detected as an independent muscle.[1] The first dorsal interosseous muscle serves as the abductor of both digits.

The third and fourth dorsal interossei (fig. 6, d^4, $d^{4'}$—d^5, $d^{5'}$) are arranged in a very peculiar and interesting manner. Each consists of two slips. In the case of the third, one of these (d^4) arises from the base of the third metatarsal, and is inserted into the outer aspect of the base of the proximal phalanx of the medius, whilst the other ($d^{4'}$) takes origin on the dorsum of the foot by two delicate heads which spring from the adjacent bases of the third and fourth metatarsal bones. Near the roots of the toes this muscular slip ends in a tendon which bifurcates, and in this manner is inserted into the adjacent sides of the bases of the proximal phalanges of the medius and annularis. The arrangement of the fourth dorsal interosseous muscle is very similar. One slip (d^5) takes

[1] In fig. 6, Plate VI., d^3 represents the deeper part of the inner head of the flexor brevis medii—the portion supposed to represent the second dorsal interosseus—artificially separated and left *in situ*.

origin from the base of the middle metatarsal bone, and crossing obliquely the metatarsal of the annular digit, is inserted into the outer side of the base of the proximal phalanx of this toe. The second slip (d^5) lies in the fourth interosseous space, and springs from the adjacent bases of the two metatarsal bones between which it lies, and, like the corresponding slip of the third dorsal interosseous muscle, ends in a tendon which bifurcates to gain a double insertion into the contiguous sides of the bases of the proximal phalanges of the annularis and minimus.

The third and fourth dorsal interossei, therefore, each consists of two slips, of which one possesses the characteristic insertion of the muscle to which it belongs, and must in consequence be looked upon as an abductor, whilst the other, by its peculiar double insertion, must act as an approximator of the digits into which it is inserted. In the *Cuscus* therefore, there is apparently a tendency to the formation of a fourth layer of muscles, endowed with a new function, by the splitting of the dorsal interossei. In the manus of the *Thylacine* a similar splitting of the dorsal interossei and the development of approximating muscles has already been noted (p. 22).

In the foot of the *Cuscus* an opponens minimi digiti is also to be found (*op.*^{5}). It is a strong quadrate muscle, placed obliquely in the pes, which arises from the outer margin of the plantar cartilage, and is inserted into the whole length of the fibular margin of the metatarsal bone, and also by a few fibres into the outer aspect of the base of the first phalanx of the minimus.

Phalangista vulpina (Australian Opossum).

The foot of this animal in external characters closely resembles that of the *Cuscus*. The hallux is broad, and opposable to the other digits. The medius and index have a common integumental covering, and the annularis is the longest of the four outer toes. Dissection however, reveals certain important points of difference in the arrangement of the intrinsic muscles.

Plantar layer.—The muscles composing this layer were found to differ in their arrangement in the two specimens which were dissected. In one they closely resembled the corresponding muscles in the *Cuscus*. Thus a median raphe extended from the base of the second metatarsal, to the outer side of the base of the proximal phalanx of the index. From this the adductor minimi digiti, the adductor annularis, and the adductor hallucis took origin. The adductor of the ring digit, however, was very feebly developed.

In the second specimen, the raphe stretched from the base of the middle metatarsal to the inner side of the base of the proximal phalanx of the annularis. From this, three muscles arose, either entirely, or in part, viz.:—

1. The adductor minimi digiti. 2. The adductor indicis.
3. The adductor hallucis.

The adductor minimi digiti was very similar to the same muscle in *Cuscus*. It took origin from the whole length of the outer margin of the raphe, and also from the bases of the third and fourth metatarsal bones, and was inserted into the inner side of the base of the proximal phalanx of the little toe.

The adductor indicis arose from the inner margin of the distal two-thirds of the raphe, and converging towards the index was inserted into the outer side of the base of its first phalanx.

The adductor hallucis was a very powerful muscle which arose from the base of the middle metatarsal bone, from the proximal third of the inner margin of the fibrous raphe and from a condensation of the fascia covering the flexor brevis indicis, and which might even be regarded as a second raphe. It was inserted upon the outer aspect of the first phalanx of the hallux, partly into the sesamoid bone, and partly into the extensor tendon.

In the first specimen, therefore, the line towards which the adductor muscles operated was one drawn through the index, as in *Cuscus*, whilst in the second specimen, the annular digit constituted the centre for these movements.

But it becomes a point of interest to inquire into the manner in which the raphe has become attached in the one case to the inner side of the base of the ring digit, and in the other case into the outer side of the index digit. If we refer back to the condition in *Dasyurus*, some light will be thrown upon this. In this animal the adductor minimi digiti and adductor indicis arise from a central raphe which has no distal attachment. From the deep surface of this the adductor annularis takes origin. Now let us suppose this last muscle to be converted into fibrous tissue, and a condition resembling that in the second specimen, the Vulpine *Phalanger*, would result. In place of this, however, say that the adductor indicis degenerates into fibrous tissue, in this case a state of affairs similar to that in *Cuscus* and the first specimen of the Vulpine *Phalanger* would be produced. A careful study of these feet renders it very probable that the fibrous raphe gains its distal attachment in this way.

Intermediate layer.—The flexores breves are well marked, and are five in number—one for each toe. With the exception of that for the little toe which is only represented by a fibular head, each muscle is composed of two slips. The flexor brevis hallucis is more powerful than the corresponding muscle in *Cuscus*. The inner head of the flexor brevis medii apparently contains in its midst the fibres of the second dorsal interosseus which is absent as an independent and separate muscle. Again, the absent inner head of the flexor brevis minimi digiti is in all probability fused with the fourth dorsal interosseus, as this muscle projects more into the sole than any of its neighbours.

Dorsal layer.—This group includes: (1) the abductor hallucis; (2) the abductor minimi digiti and abductor ossis metatarsi minimi digiti; (3) the dorsal interossei.

The abductor hallucis is very poorly developed as compared with the corresponding

muscle in the *Cuscus*, and contains a great number of tendinous fibres in its composition.

The abductors of the little toe are only two in number—one inserted into the base of the fifth metatarsal, and the other partly into the outer sesamoid bone, and partly into the extensor tendon at the base of the minimus.

The dorsal interossei are dorsal in position, and can best be inspected upon the dorsal aspect of the foot. The first or abductor indicis agrees in almost every respect with the corresponding muscle in *Cuscus*. The second, as in *Cuscus*, is apparently absent, but an examination of the inner head of the flexor brevis medii, shows that it has in reality coalesced with it, as this fleshy slip extends upwards between the metatarsals to the dorsum of the foot, so that when viewed from this aspect it seems to be the absent muscle, whilst viewed from the sole, it gives the observer the impression of its being the flexor. The third is a single-headed prismatic muscle, which takes origin from the dorsal surface of the contiguous bases of the third and fourth metatarsals. At the distal extremity of the interosseous space in which it lies, it ends in a tendon which bifurcates to be inserted into the adjacent sides of the bases of the first phalanges of the medius and annularis. Clearly, then, it acts as an approximator of these digits. This muscle therefore corresponds with the same muscle in *Cuscus*, except in its not being supplied with a separate abducting slip for the medius. The fourth dorsal interosseus is a very remarkable muscle. It is not nearly so dorsal in position as the others, still it can readily be seen between the metatarsals from this point of view. It consists of two well-marked fleshy slips. Of these one arises from the plantar aspect of the base of the metatarsal bone of the minimus, and is inserted into the summit (*i.e.*, centre) of an exceedingly powerful tendinous arch which is attached by its extremities to the adjacent sides of the bases of the proximal phalanges of the annularis and minimus. The second slip springs from the plantar surface of the base of the fourth metatarsal bone, and is inserted into the inner end of the tendinous arch (*i.e.*, that extremity which is fixed to the outer aspect of the root of the annularis). This compound muscle therefore resembles the corresponding muscle of *Cuscus*, in so far as it consists of an approximating and an abducting part—the first acting by drawing the minimus and the annularis towards each other, and the second acting by drawing the annularis away from the middle line of the foot.

Dr. Young, in his able paper upon the intrinsic muscles of the Marsupial hand,[1] describes a somewhat similar condition in the manus of the Wallaby. He says:—"The second and third dorsal interossei have a somewhat remarkable arrangement. On their dorsal aspect they closely resemble the corresponding structures in the human hand. They appear as bicipital muscles, springing from the contiguous surfaces of adjoining metacarpal bones; the fibres converge inferiorly to a common insertion, the plane of which is much more palmar in position than is that of the origin. Turning next to

[1] Journal of Anatomy and Physiology, vol. xiv. p. 154.

the palmar aspect of the muscles, two additional bellies are found occupying each of the respective interosseous spaces. These are more or less separable from the bellies seen dorsally, so that four muscular bundles—two dorsal and two palmar—are distinguishable as constituting the third and fourth (second?) dorsal interosseous muscles. All end inferiorly on a common arched tendon, which by its extremities is attached, as in the Opossum, but on a more anterior plane, reaching indeed as far as the sesamoids."

It would appear, therefore, that in certain Marsupial animals, a dorsal interosseous muscle, in addition to the usual mode of insertion, may obtain insertion in three different ways all leading the one out of the other. In the manus of the *Cuscus*, the tendon of insertion of the three outer muscles is fixed by a small transverse band to the head of the metacarpal bone of the digit, which lies adjacent to that into which the muscle is inserted. This acts so as to increase the abducting power of these mucles. In the manus of the *Thylacine* and *Cuscus*, and in the pes of the *Cuscus*, the tendon of certain of the interossei bifurcates, and is inserted into the bases of the contiguous digits. An approximating action is thus gained. Lastly, in the foot of the Vulpine *Phalanger*, and in the manus of certain other Marsupials, a fibrous arch is thrown across between the adjacent bases of two digits, and the muscles are inserted into this.

In the Vulpine *Phalanger*, a very distinct opponens minimi digiti similar in all respects to the same muscle in *Cuscus* is present.

Nerve Supply of the Intrinsic Muscles in the preceding Animals.

In *Thylacinus*, which has no hallux, all the intrinsic muscles are supplied by the external plantar nerve. In the other animals, with the exception of *Cuscus*, the abductor hallucis and the flexor brevis hallucis are supplied by the internal plantar, whilst the remaining muscles draw their nerve supply from the external plantar nerve. In *Cuscus*, however, the abductor hallucis appears to be supplied by a special branch to the hallux (fig. 5).

It is to be noted that in all these specimens, with one exception, the deep division of the external plantar in passing from the outer to the inner margin of the foot lies under cover of the plantar layer of muscles, and superficial to the intermediate and dorsal muscles. The one exception to this arrangement is to be seen, as already pointed out in *Dasyurus*, in which the nerve in turning inwards runs also under cover of the minute abductor of the minimus, which is inserted into the sesamoid bone. Ruge noticed this also in *Dasyurus hallucatus*.[1]

My friend, Dr. Young of Manchester, who has had an opportunity of examining the feet of the Koala and the Virginian Opossum, has very kindly furnished me with the notes

[1] *Loc. cit.*, p. 54.

of his dissections, and also with a plate (Pl. VII.) illustrating these. It is to be understood, therefore, that the following observations upon these two animals proceed from him.

Phascolarctos cinereus (Koala).

The foot of this animal in the undissected state is figured in Plate VII. fig. 1. It possesses five toes, of which the hallux is large, nailless, and placed at right angles to the long axis of the foot, so as to oppose the other digits. The index and medius are shorter and more slender than the other two, and are united by a common covering of skin. The four outer toes are provided with large, curved, very deep and compressed claws.

On the removal of the skin and superficial fascia from the sole of the foot, the deep or plantar fascia is seen to be well marked and arranged in the usual manner. The central portion, however, is prolonged backwards in the form of a cartilaginous tongue-like projection. This affords attachment, chiefly by its base, to most of the short muscles of the hallux and minimus and bridges over the long flexor tendons, as they enter the sole. This cartilaginous plate forms the functional heel. The backward projection of the os calcis is situated at a higher level, and from its under surface a small muscular bundle descends to the upper surface of the plantar cartilage, and acts as an elevator of the heel[1] (Pl. VII. fig. 2, *l*).

The intrinsic muscles of the foot are strongly developed, but whilst the trilaminar disposition is very evident, the dorsal or abducting layer is not complete as regards the typical number of distinct elements.

A study of the attachments and actions of the individual muscles makes it manifest that the middle line of the foot in this animal corresponds with the annularis or fourth toe, and it thus differs from the *Cuscus* and man, in both of which the index or second toe constitutes the centre for the movement of abduction and adduction, and also from the majority of mammals in which the middle line passes along the medius or third toe. It is interesting to note that the hand of the Koala agrees with the foot in this respect.[2]

Plantar layer (Pl. VII. fig. 2).—This group of muscles exhibits many evidences of muscular modifications, which can only be explained by a transference of the middle line of the foot from the medius to the annularis. It is composed of four muscles, viz.:—

1. Adductor hallucis (p^1).
2. Adductor minimi digiti (p^5).
3. Adductor of the medius and index (p^2 and p^3).
4. A slip for the annularis.

[1] This minute muscle is doubtless a differentiation of the subjacent flexor brevis digitorum.

[2] Dr. Young, Intrinsic Muscles of Marsupial Hand, Jour. Anat. and Phys., vol. xiv. p. 158.

These all lie upon the same plane and constitute an exceedingly thin but distinct muscular stratum.

The adductor hallucis arises from the plantar fascia and the ligaments over the bases of the second and third metatarsal bones. Narrowing as it passes downwards and inwards, it is inserted into the outer aspect of the base of the first phalanx of the hallux along with the tibial head of the flexor brevis hallucis.

The adductor minimi digiti is a slender and thin muscle which takes origin from the fibrous structures in relation to the base of the fourth metatarsal bone, and also from a short tendinous intersection which separates it from the muscular slip to the annularis which lies along its inner margin. It is inserted into the tibial side of the base of the first phalanx of the minimus.

The adductor medii et indicis is a broad, quadrate, continuous sheet of muscular fibres placed over the second and third metatarsal bones and the muscles in connection with them. It springs from the proximal two-thirds of a strong tendinous raphe, which stretches from the base of the fourth metatarsal to the base of the first phalanx of the annularis. It likewise derives fibres from the ligaments in relation to the bases of the second and third metatarsal bones. From this wide origin the fibres are directed towards the roots of the middle and inner digits, and as they approach these they diverge slightly so that the inner fibres pass to be inserted into the tibial aspect of the base of the proximal phalanx of the index, whilst the outer fibres go to their insertion into the fibular side of the corresponding phalanx of the medius. At the roots of these toes a few fibres pass transversely, and form a slightly arched bundle which runs directly from one digit to the other.

This muscle is undoubtedly modified in accordance with the syndactyle nature of the digits into which it is inserted, and its actions are in consequence varied.

The fourth muscular slip which belongs to this layer arises from the fibular side of the fibrous raphe, and from a tendinous intersection which separates it from the adductor minimi digiti. It is inserted into the outer side of the first phalanx of the annularis, and must therefore exercise an abducting influence upon this toe. It is difficult to account for the presence of such a distinct abductor in this layer.[1] In all probability, however, it is a portion of the adductor minimi digiti which has shifted its insertion to the adjacent digit. In support of this view we may mention that where there is a median raphe it is the custom for the adductor of the minimus to arise from the greater or indeed the entire extent of its fibular margin (*i.e.*, *Thylacine*, *Dasyurus*, *Cuscus*, Vulpine *Phalanger*), whereas in this case it is shut out from the raphe by the muscular slip in question.

Intermediate layer (figs. 2, 3, f^1 to f^5).—The usual five muscles are found entering into the composition of this layer. With the exception of the flexor brevis minimi digiti each of these muscles consists of two slips.

[1] By referring to Plate II., fig. 3, a somewhat similar slip will be seen in the manus of the *Cuscus* in connection with the index digit.

Flexor brevis hallucis (fig. 3, f^1).—The two bellies of this muscle are separated by the tendon of the flexor longus hallucis. They have a common origin from the thickened part of the plantar cartilage close to the base of the first metatarsal bone. Each belly is joined by the abductor and adductor respectively, and is inserted one into the inner sesamoid bone and the other into the outer sesamoid bone at the base of the first phalanx of the hallux.

The succeeding three flexores breves (fig. 3, f^2 to f^4), viz., for the index, medius, and annularis present the usual arrangement. That for the annular digit, however, is the strongest of the series, seeing that it is in connection with the longest toe. Both bellies of this muscle arise from the base of the third metatarsal bone, and therefore they lie obliquely in the sole. This muscle also differs from the other members of the series in being inserted not only into the sesamoid bones but likewise into the extensor tendon.

The flexor brevis minimi digiti (fig. 3, f 5') is represented merely by a slender tibial head which arises by a long tendon from the cuboid bone. The fibular head is inseparably united with the opponens minimi digiti.

Dorsal layer (d^1 to d^6 *a.m*).—This layer is represented by only four muscles.

1. The abductor hallucis (d^1).
2. The abductor minimi digiti (d^6).
3. The abductor ossis metatarsi minimi digiti (*a.m*).
4. The abductor indicis or first dorsal interosseus (d^2).

The abductor hallucis arises from the inner margin of the cartilaginous portion of the plantar fascia and is inserted into the tibial side of the first phalanx of the hallux in conjunction with the inner head of the flexor brevis of the same toe.

The abductor minimi digiti takes origin from the inferior surface and outer border of the os calcis. It likewise receives a small separate slip from the plantar cartilage. The fleshy belly of the muscle soon ends in a long tendon which is inserted into the outer side of the proximal extremity of the first phalanx of the minimus. In all probability the small fasciculus which is derived from the plantar cartilage represents the third factor of the abducting apparatus on the outer margin of the foot.

The abductor ossis metatarsi minimi digiti arises from the os calcis in common with the preceding muscle. It has the usual insertion into the base of the fifth metatarsal bone immediately under that of the peroneus brevis.

The abductor indicis consists of fibres which extend between the adjacent margins of the first and second metatarsal bones. It also arises by a long narrow tendon which lies under cover of the flexor brevis hallucis and springs from the tibial side of the base of the metatarsal bone of the hallux. The muscle is inserted mainly into the inner aspect of the base of the first phalanx of the index, but some fibres are likewise inserted into the hallux along with the adductor hallucis.

Macalister[1] describes an opponens hallucis, springing from the internal cuneiform and inserted into the first metatarsal bone, but in six feet examined by Dr. Young no trace of this muscle could be detected. The small tendon of the preceding muscle which takes origin from the inner side of the base of the metatarsal bone of the hallux may exercise a slight opposing action.

An opponens minimi digiti (figs. 2 and 3, *o.m*), however, is always present. It is a thin, but well-developed muscle which springs from the outer margin of the plantar cartilage, and is inserted into the fibular margin of the shaft of the fifth metatarsal bone. The superficial fibres are prolonged to the base of the first phalanx of the minimus, and constitute the only representative of the outer head of the flexor brevis of that digit.

Didelphys virginiana (Virginian Opossum), (Pl. VII. figs. 4 and 5).

The foot of this animal is pentadactylous. The four outer toes are all well-developed, and quite separate the one from the other. The hallux is placed at right angles to the long axis of the foot so as to oppose the other digits, and it is destitute of a nail.[2]

Upon the plantar aspect of the internal cuneiform bone, a well-marked sesamoid bone is situated. From this a tongue-like cartilaginous prolongation proceeds which affords attachment to some of the muscles of the hallux.

In this foot the trilaminar disposition of the intrinsic muscles is very marked. Dr. Young has also shown that in the hand of the same animal the corresponding muscles are arranged upon a similar plan.[3]

Plantar layer (p^1 to p^5).—This group comprises adductors of all the digits with the exception of the medius, which in this case constitutes the centre for the movements of adduction and abduction.

The adductor hallucis (p^1) and the adductor minimi digiti (p^5) are large, flat, triangular muscles. They take origin, by their bases, from a mesial fibrous raphe which extends from the base of the middle metatarsal bone to the base of the proximal phalanx of the medius. The adductor minimi digiti also derives fibres of origin from the ligamentous structures over the proximal ends of the fourth and fifth metatarsal bones. They are inserted by their apices—the one into the outer aspect of the base of the first phalanx of the hallux and the other into the inner side of the base of the proximal phalanx of the minimus.

Together these muscles constitute a continuous muscular sheet of a trapezoidal form, intersected by the fibrous raphe, which extends from the upper to the lower angle. It almost entirely conceals the other muscles of this group.

[1] Muscular Anatomy of the Koala, Annals and Magazine of Natural History, vol. x. (fourth series), 1872, p. 133.

[2] In Waterhouse's work upon Mammalia, a figure of the foot of *Didelphys cancrivora* is given pl. xii. vol. i.

[3] *Loc. cit.*, p.

The adductor indicis (p^3) and adductor annularis (p^4) arise from the deep surface of the greater part of the fibrous raphe under cover of the preceding muscles. They are inserted one into the outer aspect of the base of the proximal phalanx of the index, and the other into the inner side of the corresponding phalanx of the annularis.

In this group of muscles we have another striking illustration of the tendency of the marginal adductors to usurp the middle line by thrusting back the central adductors, and coalescing in the middle line superficial to them. It is a further stage of what we observed in *Dasyurus*, in which the adductors of the hallux, index, and minimus are upon the same plane, and the adductor annularis upon a deeper plane. Here the adductors of the hallux and minimus have come to lie superficial to the adductors of the index and annularis.

Ruge in his article upon the short muscles of the foot[1] figures and describes the muscular and nervous anatomy of the pes of *Didelyphys cancrivora*. In this case the adductor annularis as in *Dasyurus* is the only member of the adducting group which lies under cover of the others. The adductor indicis is a weak muscle which springs from the inner margin of a small portion of the lower end of the median raphe, and therefore lies upon the same plane as the adductors of the hallux and minimus.

Intermediate layer (f^1 to f^5).—Each digit is provided with a flexor brevis, and each of these five muscles is composed of two slips. The two heads of the flexor brevis hallucis are much more strongly developed than those of the other members of this series.

Meckel in the sixth volume of his work upon Comparative Anatomy (p. 466) states that in *Sarigues* (*i.e.* Opossums) the short flexor of the hallux is absent. He adds however, "the adductor is of medium size and divided into two heads which spring very close to each other. . . . They go solely to the base of the first phalanx." Clearly he looks upon the outer head of the flexor brevis as the caput obliquum of the adductor hallucis and the muscle which Dr. Young has named the adductor hallucis as being the caput transversum, or in other words the transversalis pedis. Ruge in his description of the foot of *Didelphys cancrivora* agrees with Meckel, and supports this view by asserting that the muscle in question is supplied by the deep division of the external plantar nerve. He says:—"The muscle for the first toe is already in *Didelphys* separated into two heads. The part arising in common with the fifth contrahens (*i.e.*, adductor minimi digiti) represents the transverse head and the part from the base of the second metatarsal represents the oblique head. Both heads are like the other contrahentes (*i.e.*, adductors) supplied by the external plantar nerve." The presence of the inner head of the flexor brevis hallucis as a muscle distinct from the abductor hallucis is denied by Ruge as well as by Meckel.

[1] *Loc. cit.*, p. 54.

Dorsal layer (d^1 to d^5).—This layer includes—

1. Abductor hallucis (d^1).
2. Abductor minimi digiti (d^5).
3. Abductor ossis metatarsi minimi digiti ($a.m$).
4. Dorsal interossei.

The abductor hallucis (d^1) arises from the sesamoid bone at the base of the first metatarsal bone, and from the adjoining ligaments. It is inserted into the base of the proximal phalanx of the hallux, along with the inner head of the flexor brevis.

The adductor minimi digiti (d^5t and d^5f) arises by two distinct heads. Of these one springs from the outer surface of the os calcis and consists of a fusiform muscular bundle, ending in a long tendon, whilst the other, fleshy throughout, takes origin from the lower border of the annular ligament. Both heads are inserted into the fibular side of the base of the first phalanx of the minimus.

The abductor ossis metatarsi minimi digiti ($a.m$) has a similar disposition to the same muscle in Koala.

Here again, therefore, is another instance of the abducting apparatus on the outer margin of the foot showing a triple arrangement.

The dorsal interossei are four in number. They are single headed muscles, and are inserted so as to act upon the index, medius, and annularis with reference to a line drawn through the middle digit. This toe is therefore provided with two. A slight tendency to fusion between these muscles and the flexores breves is exhibited.

Neither the hallux nor the minimus is provided with an opponens.

Macropus robustus.

The foot of this animal is far from being symmetrical It is tetradactylous, the hallux being completely suppressed. The annularis is enormously developed; the minimus is well marked but not so long as the fourth toe, whilst the index and medius are exceedingly slender, and are enclosed within the same covering of integument. The intrinsic muscles in this foot are deficient both as regards number and development.

Plantar layer.—This layer has only one representative, viz., the adductor minimi digiti, and even this shows signs of regressive change. The proximal two-thirds of this muscle consist of a thin tendinous band, which arises from the fibrous textures upon the plantar surface of the base of the fourth metatarsal bone. The distal third alone is fleshy, and is inserted upon the base of the first phalanx of the minimus, partly into the sesamoid bone, and partly into the extensor tendon. It is distinctly plantar in position.

Intermediate layer.—Each digit has in some form or other a flexor brevis, but that for the annularis is the only one which is well developed. The flexor brevis minimi digiti, like the adductor of the same toe, is fibrous in its proximal two-thirds, and composed of a round tendinous cord which takes origin from the plantar surface of the base of the

fifth metatarsal bone. From the distal end of this, two small fleshy bellies proceed, and these are inserted into the sesamoid bones at the base of the first phalanx of the minimus. A few short oblique fleshy fibres are observed upon the outer surface of the tendinous part of the flexor brevis minimi digiti. These probably represent the abductor minimi digiti.

The flexor brevis annularis is a strongly developed muscle, which lies upon the plantar surface of the fourth metatarsal, and takes origin from the base of the fifth metatarsal bone. Its two heads do not separate from each other until the muscle reaches the metatarso-phalangeal joint. They are then inserted into the sesamoid bones at the base of the annularis.

Two delicate fleshy slips which lie upon the plantar surface of the attenuated metatarsals of the index and medius, and are inserted into the inner sesamoids of these toes, in all probability represent the inner heads of the flexor brevis indicis, and flexor brevis medii respectively.

Dorsal layer.—The members of this group have disappeared. Traces of two, however, are to be found. The abductor minimi digiti is evidently represented by the short fleshy fibres which are found adhering to the outer surface of the fibrous part of the flexor brevis minimi digiti. The fourth dorsal interosseous muscle is present in the form of strong aponeurotic fibres which bind the fourth and fifth metatarsal bones together.

Nervous arrangements.—All the muscles are supplied by the external plantar nerve.

Monotremata.

Ornithorhynchus paradoxus (Duck-mole) (Pl. IX. fig. 5).

The intrinsic muscles in the pes of this animal present a very complicated arrangement, and the following account of their disposition is the result of the dissection of both feet of four specimens. The plantar layer is always quite distinct, but a considerable degree of fusion usually exists between the members of the intermediate and dorsal layers.

Plantar layer.—This group is composed of four muscles, arranged so as to adduct the toes towards the index or second digit. They are—

1. The adductor minimi digiti.
2. The adductor annularis.
3. The adductor medii.
4. The adductor hallucis.

All these have a common origin from the plantar surface of the external and middle cuneiform bones.

The adductor minimi digiti is the largest of the series, and is placed very obliquely in the sole. It is chiefly inserted upon the tibial aspect of the base of the first phalanx of the minimus, but it also sends a slender fleshy process forwards upon the inner aspect of the digit, so as to gain attachment to the second phalanx.

The other three adductors are inserted respectively into the inner sides of the bases of the first phalanges of the annularis and medius, and into the outer side of the base of the first phalanx of the hallux.

In the foot of one very large specimen, I found a delicate muscular fasciculus apparently associated with these muscles and inserted into the outer side of the base of the first phalanx of the medius. I could detect no trace of this minute muscle in the other specimens and it is difficult to account for its presence in this individual case.

In Ruge's excellent paper upon the deep muscles of the sole two additional muscles are described as belonging to this group, viz., one inserted into the inner side of the index digit and another inserted upon the outer side of the minimus. I have looked in vain for the first of these, and the deep division of the external plantar nerve afforded me no help in my search. As Ruge has pointed out, this nerve generally runs across the foot between the adductors and the other intrinsic muscles so as to separate this group from the subjacent flexors and abductors. In the *Ornithorhynchus* I found it impossible to trace this nerve inwards beyond the muscles of the index. It here breaks up into its delicate terminal twigs, in a manner very different from that which is represented by Ruge in fig. 46 of his paper.

With regard to the extra plantar muscle which he describes for the minimus, I have not the least hesitation in pronouncing this to be the outermost belly of the flexor brevis digitorum. I have undertaken three special dissections with the view of determining this point. The flexor brevis digitorum consists of four fleshy bellies. Of these the two for the index and medius arise from the plantar surface of the long flexor tendon as it enters the sole, whilst the other two (viz., those for the annularis and minimus) spring by a common fleshy origin from the under surface of the outwardly directed tuberosity of the os calcis. They are all inserted into the bases of the first phalanges and also partly into the flexor sheathes of the digits to which they go.[1] The identity of the outermost belly is established (1) by its origin being so far apart from that of the plantar muscles, (2) by its continuity at its origin with the fleshy belly of the flexor brevis digitorum for the annular digit, (3) by its lying superficial to the long flexor tendon of the minimus, (4) and lastly, by its having an insertion similar to that of the other bellies of this muscle. It is quite true, as Ruge points out, that it is supplied by a twig from the external plantar nerve, but this of itself is not sufficient to separate it from the muscle to which it so manifestly belongs.[2]

[1] Meckel in his great work upon Comparative Anatomy (*loc. cit.*, vol. vi. p. 447) holds a different opinion regarding these four fleshy bellies. He looks upon them as being the lumbrical muscles. He says: "Le tendon inférieur produit deux muscles lombricaux alongés, qui se rendent à la premiére phalange des deuxième et troisième orteils. Deux muscles sembables, distinés aux troisième (?) et quatrième orteils, sont fournis, non par ce tendon, mais par le bord externe du tarse." The nerve supply certainly seems to favour this view. A reference to page 461 of same volume will show that the second "troisième" in this quotation, should in reality be "cinquième."

[2] In Cuvier and Laurillard's plates (pl. cclxix. fig. 5) the four fleshy bellies are well figured, and they are all included under the name of "court fléchisseur commun."

The dorsal layer.—This layer consists of four dorsal interosseous muscles and an abductor ossis metatarsi minimi digiti.

The abductor ossis metatarsi minimi digiti is a short powerful muscle which takes origin from the outer side of the tuberosity of the os calcis, and is inserted into the fibular aspect of the base of the metatarsal bone of the minimus. This is the only abductor of the minimus, but the outermost belly of the flexor brevis digitorum, from its being inserted upon the outer side of the first phalanx, must in addition to its flexing power possess a very considerable abducting influence, and in this way help to spread out the integumental web which connects the digits.

The dorsal interossei (Pl. IX. fig. 5) have a very complex arrangement, and in order to obtain a proper understanding of them they must be dissected from the dorsal aspect of the foot before the flexores breves are interfered with. The fourth dorsal interosseous (d^5) muscle is single headed and inseparably united with the outer head of the flexor brevis annularis. It arises from the dorsal surface and outer side of the fourth metatarsal bone, and is inserted into the outer side of the extensor tendon of the annularis.

The third dorsal interosseus (d^4) at first sight appears to consist of a single large head which springs from the dorsal aspect of the fourth metatarsal, but on separating the bones between which it is placed a second and much smaller head is discovered lying along its inner side, and taking origin from the outer aspect of the base of the third metatarsal. These slips, but more especially the larger one, are partially fused with the flexores breves of the annularis and medius respectively. Both heads unite near the roots of the toes, and end in a fibrous arch which extends between the contiguous sesamoid bones of the medius and annularis.

The second dorsal interosseus (d^3) is also two-headed, and partially fused with the corresponding slips of the flexores breves of the medius and index. The larger and outer slip springs from the dorsal surface of the third metatarsal near its base, whilst the smaller slip, not so dorsal in position, takes origin from the contiguous bases of the third and second metatarsals. The majority of the fibres are inserted into a fibrous arch thrown across between the adjacent sesamoid bones of the medius and index; the other fibres end in a tendon which passes forward upon the dorsal surface of the arch (with which it is closely united) and finally splits into two delicate slips. These diverge from each other, and are inserted into the extensor tendons on the dorsal aspect of the medius and index. The second and third dorsal interossei, therefore, act as approximators of the index, medius, and annularis. Further, it would appear as if this were the first stage of the process, which was seen completed in the *Cuscus*, where certain of the dorsal interossei are differentiated into approximators and abductors. Here each of the muscles in question consists of two parts, but these have not attained separate insertions. The first dorsal interosseus (d^2) is a small slip which arises from the dorsum and inner surface of the second metatarsal. In most cases it is inseparably fused with the inner head of the

flexor brevis indicis. Lying along the inner side of this muscle is a strong fibrous cord which is attached by its proximal end to the base of the second metatarsal bone. Its distal end splits into two parts which stretch across between the adjacent sesamoids of the index and hallux. The fleshy fibres of the muscle are inserted into the inner sesamoid of the index, through the agency of the outer limb of this fibrous band. The fibrous cord is thus the undoubted representative of the inner head of the first dorsal interosseus, such as is present in the case of the second and third dorsal interossei.

Ruge figures and gives a short description of the dorsal interossei in the *Ornithorhynchus*. He represents them as single-headed muscles, with simple insertions, and so placed as to abduct the toes from a line drawn through the index. I have not seen this arrangement in any of the specimens I have examined.

Intermediate layer.—Whilst there can be no doubt as to the presence of a series of flexores breves, constituting an intermediate layer, the individuality of these muscles is, in a great measure, obscured by their more or less complete fusion with the dorsal interossei. The two heads also of each member of the group show a tendency to coalesce, so that an examination of them, before they have been thoroughly cleaned, gives rise to the impression that each consists of a single fleshy belly, lying upon the metatarsal bone, and inserted into the plantar surface of the base of the proximal phalanx of the digit, with which it is connected. A careful dissection, however, will reveal the fact that they are, as a general rule, two-headed. To effect their separation from the dorsal interossei, it is necessary to reflect the latter muscles from the dorsal aspect of the foot. It is then seen that whilst in some cases the heads of the flexores breves are inseparably united with the dorsal interossei, yet in other cases the union is only partial.

In a young male specimen which I had the opportunity of examining there was little or no fusion between the flexores breves and the dorsal interossei, whereas, on the other hand, the heads of the individual muscles were closely united. This coalescence between the heads of the flexores breves would seem to indicate that the usual two slips of each muscle are derived originally from a single fleshy mass.

Each digit, with the exception of the minimus, is provided with a flexor brevis. These present the usual attachments, but their insertions are more plantar in position. The flexor brevis hallucis is a single bellied muscle which takes origin from the internal cuneiform bone, and is inserted into the inner side of the base of the first phalanx of the hallux. From its taking a more proximal origin than its neighbours, it is probable that it holds in its midst the fibres of the absent abductor hallucis. Indeed Ruge applies this name to the entire muscle. I think, however, that it is better to look upon it as a combination of both.

Plantar nerves.—The plantar nerves have an arrangement in the foot of the *Ornithorhynchus* somewhat different from that generally found throughout Mammalia. The internal plantar nerve alone enters the sole by the hollow of the os calcis, in company with

the tendon of the flexor longus digitorum. In the sole it gives twigs to the flexor brevis digitorum, and then breaks up into cutaneous branches for the digits and web. These supply both sides of the hallux, of the index, and of the medius, and also the tibial side of the annularis. The external plantar nerve reaches the foot by passing over the outer side of the os calcis. Upon the fibular margin of the pes it divides into a minute superficial twig for the outer side of the minimus, and a large deep branch. Before dividing, the nerve trunk gives twigs to the abductor ossis metatarsi minimi digiti, the outermost belly of the flexor brevis digitorum, and the accessorius. The deep division turns inwards under cover of the superficial and deep flexors of the toes, and insinuating itself between the plantar and intermediate muscles divides into a large cutaneous and a small muscular part. The cutaneous nerve emerges at the lower border of the adductor minimi digiti and bifurcates to supply the adjacent sides of the minimus and annularis, whilst the muscular branch continues inwards under cover of the adducting muscles as far as the metatarsal of the index, where it breaks up into its terminal filaments. It supplies all the intrinsic muscles, with the exception of the abductor ossis metatarsi minimi digiti, which receives its nerve direct from the trunk of the external plantar, and the flexor brevis hallucis, which is probably supplied by the internal plantar nerve, although it is right to state that I have been unable to trace any nervous filament to this muscle.

A passage in Meckel's work upon Comparative Anatomy regarding the interossei in the pes of the *Ornithorhynchus* led me also to examine the corresponding muscles in the hand of this animal. He says:—"Dans l'ornithorhynchque, ils se comportent absolument de la même manière que les interosseux de la main; à cela pres qu'ils sont plus minces et plus grêles." I found the arrangement very different. Thus the plantar layer is only represented by a single minute thread-like muscle—the adductor minimi digiti. The dorsal interossei are also absent, but, in the intermetatarsal spaces, strands of tough fibrous tissue exist, and these may represent them. The intermediate flexores breves are well marked, each being composed of two fleshy slips with the exception of that for the minimus, which has only an inner or ulnar head.

Echidna setosa (Pl. IX. fig. 6).

The foot of the Echidna is pentadactylous, powerful, and somewhat peculiar in its form. The hallux is exceedingly short and stunted, and is provided with a short rounded nail which covers the entire dorsal surface of the digit. The index is considerably longer than the other toes, and is armed with a remarkably long curved claw. The succeeding digits gradually diminish in size as we proceed towards the minimus, and each is furnished with a claw similar in shape to that of the index, but of a size proportionate to that of the digit to which it belongs. The intrinsic muscles of this foot are very weakly developed, and many are absent. The stunted hallux is

provided with rudiments of the three typical muscles which properly belong to this toe. The index also has its complement of muscles, but these are not so distinctly mapped off from each other, as in the case of the hallux. The minimus has an adductor and a flexor brevis, whilst the annularis and medius are only furnished with adductors. But what is particularly noticeable about these muscles is, that they are all (with the exception of the flexor brevis minimi digiti) manifestly undergoing retrograde change. The adductors indeed are so thin that they are semi-transparent.

In the specimen which I dissected, the flexor longus digitorum sent no tendon to the minimus, consequently the outermost belly of the flexor brevis digitorum (*f.d*) is retained for this digit, and is very apt to be mistaken for an intrinsic muscle seeing that the other three bellies are altogether suppressed. This solitary portion of the short flexor of the toes takes origin from the plantar fascia and the tuber of the os calcis, and is inserted into the plantar surface of the base of the second phalanx of the little toe. It is partially fused with the subjacent flexor brevis minimi digiti which obscures its identity still further. St. George Mivart, however,[1] in his well known memoir upon the *Echidna hystrix*, describes a tendon as passing from the long flexor of the toes to the minimus, and denies the presence of any portion of the short flexor.

Adductor or plantar layer (p^1 to p^5).—This layer is well represented, each digit being supplied with one, and the annularis with two. They are inserted so as to draw the digits towards the interval between the index and hallux.

The adductor hallucis (p^1) and adductor indicis (p^2) arise by a common origin from the under surface of the os calcis close to the outer margin of the foot. They cross the sole obliquely, and are placed superficial to the common origin of the other members of this group. The adductor hallucis is a very slender slip which, ending in a minute tendon, is inserted into the outer side of the base of the ungual phalanx of the hallux. The adductor indicis, more strongly marked, ends in a flat aponeurotic tendon which is inserted upon the inner aspect of the second phalanx of the index.

The remaining adductors (p^3, p^4, and p^5) have a common origin from the ligamentous textures upon the under surface of the tarsus, and diverge from each other to reach their respective points of insertion. They are thin bands which end in flat aponeurotic tendons. These are inserted into the tibial sides of the ungual phalanges of the medius. annularis, and minimus respectively. The annularis possesses, however, a very delicate additional fasiculus ($p.\ 4^1$) which seems to belong to this layer seeing that it lies superficial to the deep division of the external plantar nerve, and arises in common with the three outer members of the group. This minute slip is inserted into the plantar aspect of the first phalanx of the annular digit. In all probability it is analogous to the additional

[1] Some Points on the Anatomy of *Echidna hystrix*, by St. George Mivart, F.L.S. (Trans. Linn. Soc., vol. xxv. p. 394).

adducting slip occasionally found in connection with the medius in the foot of the *Ornithorhynchus*. Certainly its presence is equally unaccountable.

Intermediate layer.—Only three muscles of this layer are present, viz.—

1. Flexor brevis hallucis (f^1).
2. Flexor brevis indicis (f^2).
3. Flexor brevis minimi digiti (f^5).

The flexor brevis hallucis although very minute, is yet complete in so far that it possesses two heads. These arise by a common origin from the fibrous structures on the plantar surface of the middle cuneiform bone. Diverging from each other they are inserted into the sides of the second phalanx of the hallux.

The flexor brevis indicis has also two heads, but the tibial head alone is fleshy. It is composed of a collection of very short muscular fibres, which arise from the under surface of the middle cuneiform bone, and are inserted into the inner and plantar aspect of the first phalanx of the index. The fibular head is represented by a short fibrous cord which lies along the outer side of the head.

The flexor brevis minimi digiti is the best developed muscle of the intrinsic group. It is represented by the outer head alone. This springs from the anterior aspect of the projecting tuber of the os calcis and is inserted into the outer side of the second phalanx of the minimus. It is covered by the outermost belly of the flexor brevis digitorum with which it is partially united.

Dorsal layer.—Only two muscles belonging to this group are found, viz.—

1. The abductor hallucis (d^1)
2. The second dorsal interosseus (d^2).

The abductor hallucis, which is very rudimentary, arises from the fascia at root of the hallux and is inserted by a minute thread-like tendon into the tibial aspect of the ungual phalanx of this digit.

The second dorsal interosseus muscle is also very small. It lies in the second intermetatarsal space, but can only be detected from the plantar aspect, of the foot. Tapering towards its distal extremity, it terminates in a tendon which splits into two portions, a very delicate hair-like part for the tibial side of the second phalanx of the medius and a much stronger part for the fibular side of the second phalanx of the index. Whilst therefore the main action of this muscle must be regarded as that of an abductor of the index, opposing in this respect the adductor indicis, it nevertheless possesses through its minute insertion into the medius an approximating influence upon the index and medius.

In the pes of the Echidna there is no clue as to what has become of the absent intrinsic muscles. It is probable that they are lost by suppression. A strange feature

also in connection with this foot is that the stunted hallux, which of all the digits possesses the most limited range of movement, should be the only one to retain its full complement of muscles.

Nervous arrangements.—These present certain characteristic peculiarities. The internal plantar nerve enters the sole by the hollow of the os calcis where it is found lying upon the inner side of the long flexor tendon. It ends by dividing into three digital branches which are distributed as follows, (1) the first runs along the tibial side of the hallux, (2) the second bifurcates to supply the adjacent sides of the hallux and index, (3) and the third divides to supply the contiguous margins of the index and medius. The first or innermost of these digital branches gives a minute twig to supply the abductor and flexor brevis of the hallux. In the leg, long before it reaches the foot, the internal plantar nerve gives off a slender branch which inclines outwards over the flexor longus digitorum, and is then continued upon the outer aspect of the tuber of the os calcis to its distribution upon the fibular border of the foot, and the fibular side of the minimus. It also gives a twig to the solitary belly of the flexor brevis digitorum. This nerve is probably a substitute for the superficial division of the external plantar nerve which is absent in the foot of the Echidna.[1]

The external plantar nerve (*e.p.n.*) also gains the sole, by passing through the hollow of the os calcis. In this situation, however, it lies upon the outer side of the tendon of the flexor longus digitorum and under shelter of the outwardly directed tuberosity of the os calcis. It does not divide into a superficial and a deep branch, but is prolonged downwards as an unbroken trunk upon the accessorius, and under cover of the solitary belly of the flexor brevis digitorum. Suddenly turning inwards, it runs across the sole under cover of the plantar layer of muscles and ends at the tibial margin of the foot in twigs for the adductors of the hallux and index. It gives off (*a*) muscular and (*b*) digital branches.

The muscular branches supply the accessorius and all the intrinsic muscles with the exception of the abductor hallucis and flexor brevis hallucis. The digital branches are two in number. The first proceeds from the nerve trunk before it turns inwards under cover of the plantar muscles, and piercing the adductor minimi digiti divides to supply the adjacent sides of the minimus and annularis. The second digital branch takes origin under cover of the adductor annularis and bifurcates, to supply the contiguous margins of the annularis and medius. This is a peculiar arrangement. The internal plantar nerve gives off a branch which almost invariably springs from the external plantar, viz., the digital branch for the outer side of the minimus, and as it were in return for this, the external plantar gives a nerve which should come from the internal plantar, viz., the digital nerve for the opposed sides of medius and annularis.

[1] Have we not here an explanation of the peculiarity of the nerve-supply of the outermost belly of the flexor brevis digitorum in the *Ornithorhyncus*? In this animal the external plantar takes very much the same course as this branch, and it is probable that it contains, in its midst, the fibres of this nerve.

Carnivora.

Of the Carnivora I have examined the feet of the domestic Dog (*Canis familiaris*), the Dingo (the Australian Wild Dog), the Cat (*Felis catus*), the Puma (*Felis concolor*), the Leopard (*Felis leopardus*), the Lion (*Felis leo*), the Otter (*Lutra vulgaris*), the Badger (*Meles taxus*), the Pole-Cat (*Mustela putorius*), and the Walrus (*Trichechus rosmarus*). In the last four the foot is pentadactylous, whilst in the others it is tetradactylous—the hallux being only represented by a rudimentary metatarsal.

Let us, in the first instance, direct our attention to the tetradactylous Carnivora. In these the metatarsal bones are placed in such close apposition, that the intrinsic muscles of the pes are situated almost entirely upon the plantar aspect of the metatarsus. In the Dog, indeed (Pl. VIII. fig. 4), it is with difficulty that the point of a knife can be introduced into the interosseous spaces. In the Cat, Puma, Leopard (Pl. VIII. fig. 7), and Lion, whilst the bones are in actual contact towards the tarsus, yet they open out towards their phalangeal extremities, and in the narrow eliptical spaces thus formed, the thin, sharp edges of the dorsal interossei may be seen reaching half-way up the interosseous spaces (Pl. VIII. fig. 7, d^3 to d^5).

Owing to this arrangement of the metatarsal bones, the intrinsic muscles are crowded into the sole; further, the clear definition between the three typical layers is in a great measure lost. None of the muscles are suppressed, but fusion has taken place between several which in other feet we have seen as separate and distinct factors. The cause of this fusion, however, cannot be assigned to crowding, because in *Phascogale*, and especially in *Dasyurus*, the condition of the metatarsus is very similar, and yet all the intrinsic muscles have retained their individuality in spite of the limited space they occupy.

Plantar layer.—In all cases the adductor muscles remain as a distinct plantar layer, and they are arranged so as to adduct towards a line drawn through the medius. Generally they are two in number,—viz., (1) the adductor minimi digiti (Pl. VIII. fig. 8, p^5); and adductor indicis (Pl. VIII. fig. 8, p^2). Occasionally a third is to be found in the Dog—an adductor annularis; but this is feebly developed, and always more or less fused with the tibial head of the flexor brevis of that toe. This seems to indicate that in the other animals this muscle is lost by fusion and not by suppression. These adductor muscles, whether two or three in number, all arise by a common origin in the middle line of the foot from the ligamentous textures at the base of the metatarsus, and then diverge from each other to reach their respective points of insertion.

Associated with the plantar layer is the opponens minimi digiti (Pl. VIII. fig. 8, *o.m*). It is a narrow band of fibres which arises in common with the adductor of the little toe, and is inserted into the plantar face of the distal third of the shaft of the fifth metatarsal bone, under cover of the flexor brevis minimi digiti. This muscle was found in all the tetradactylous Carnivora mentioned above.

Dorsal and intermediate layers (Pl. VIII. fig. 8, f^2 to f^5 and d^2 to d^6).—It is in the dorsal and intermediate layers that we find the greatest deviation from our type. The flexores breves (f^2 to f^3), and the dorsal interossei have undergone a partial or complete amalgamation; still there are usually traces left of a character sufficiently patent to enable the dissector to determine the complex character of the muscles with which he has to deal. As a rule, the fusion is complete towards the middle of the metatarsal bone, whilst towards the origin and insertion a partial separation can be effected. But even in cases where no true and natural separation can be made out, a close examination will usually show tendinous intersections running through the muscles, and these afford a clue to their composite character.

The mode of insertion cannot be regarded as giving a sure means by which these fused muscles can be distinguished from each other. The dorsal interossei, it is true, are almost invariably inserted into the extensor tendon; but, on the other hand, the flexores breves are not in all cases inserted into the sesamoid bones alone. One of the two slips is frequently inserted into the extensor tendon as well.

The fused flexores breves and dorsal interossei constitute a series of muscles which are frequently described as bicipital, whilst in reality they are tricipital, and, in the case of the medius, quadricipital.

The dorsal interossei are disposed so as to abduct the toes from a line drawn through the medius. In no case do they arise from the shafts of the metatarsal bones.

It is interesting to note the different dispositions of the abducting apparatus of the little toe in these animals. A tendency is exhibited to its disappearance by fusion with the outer head of the flexor brevis minimi digiti.

In the Leopard it is the most strongly developed. Here we find (1) a well-marked abductor ossis metatarsi minimi digiti (fig. 8, *a.o*), (2) an abductor minimi digiti (d^6), and (3) a small slip which seems to belong to this apparatus. The abductor of the metatarsal bone, and the abductor of the little toe, have a common origin from the proximal and outer aspect of the os calcis. Separating from each other, the former is inserted into the projecting base of the fifth metatarsal bone, whilst the latter is inserted by a long narrow tendon upon the outer face of the base of the first phalanx of the minimus. The small fleshy slip referred to above springs from the base of the fifth metatarsal, at a higher level than the flexor brevis of the little toe, and after a short independent course it fuses with the outer head of that muscle. Is this not the third abductor of the minimus which we have seen present in some of the Marsupials? Against this view, however, is the fact that the tendon of the abductor minimi digiti is inserted both into the sesamoid bone, and into the extensor tendon, on the dorsum of the first phalanx.

In the Puma the arrangement is similar in every respect, except that no trace of the third small supernumerary slip can be detected, and that the slender tendon of the abductor minimi digiti is inserted into the extensor tendon alone.

In the Lion there is a powerful abductor ossis metatarsi and a weak abductor minimi digiti. These are coalesced at their origins for the distance of about an inch. Separating from each other the former attains its usual insertion, whilst the latter is continued onwards as a flat tendon which lies upon and is incorporated with the outer surface of the fibular head of the flexor brevis minimi digiti. Its continuity in this position is quite apparent to the eye. Towards the root of the toe it again becomes separate to join the extensor tendon on the dorsum of the first phalanx of the minimus.

In the Dog not a trace of an abductor of any kind for the little toe is present as a distinct muscle. In one specimen the fibular head of the flexor brevis at its insertion exhibited a slight tendency to split, which might be taken as an indication that this muscle has absorbed by fusion the abductor.

Meles taxus (Badger).

Passing now to the pentadactylous Carnivora, we find that the plantigrade foot of the Badger approaches the typical trilaminar arrangement of intrinsic muscles more nearly than the digitigrade pes of the tetradactylous Carnivora. Still it presents some important deviations.

Plantar layer—This layer is well marked, and the muscles composing it are very readily separated.

They are three in number, viz.—

1. Adductor hallucis. 2. Adductor minimi digiti.
3. Adductor indicis.

These muscles all arise side by side and in one plane from the bases of the second and third metatarsal bones, and then radiate from each other to reach their distal attachments. They are inserted in such a manner as to act as adductors of their respective digits towards a line drawn through the medius. No trace could be found of an adductor annularis or of an opponens minimi digiti.

Intermediate layer.—An undoubted tendency to coalescence between members of this layer and the dorsal layer is exhibited. Certain of the heads of the flexores breves are in consequence lost.

The hallux, the index, and the minimus, are each provided with a double-headed flexor brevis which presents the usual connections. The flexor brevis annularis and the flexor brevis medii are merely represented by single tibial heads. No indication of the lost head of the latter muscle exists, but it is likely that the bulky third dorsal interosseus holds its fibres in its midst. There is no difficulty in tracing the fibular head of the flexor brevis of the ring digit. It is partially united with the fourth dorsal interosseous muscle. At its origin it is quite separate, but very soon the two muscles become completely fused.

Dorsal layer.—This layer like the preceding is not represented by its full complement of muscles. It is composed of—(1) an abductor ossis metatarsi minimi digiti which presents the usual attachments; and (2) four dorsal interossei which are arranged so as to abduct the digits, with reference to a line drawn through the medius. This digit therefore is provided with two members from this group.

The absence of the abductor minimi digiti is readily accounted for by an examination of the outer head of the flexor brevis of this toe. The great bulk of this slip, and the fact that it takes its origin at a more proximal point than its neighbours (from the surface of the long plantar ligament) leads to the conclusion that the lost muscle has coalesced with it. Upon similar grounds also we conclude that the absent abductor hallucis is contained within the inner head of the flexor brevis of the hallux.

Dr. Ruge in his article upon the deep muscles of the sole gives a figure of the adducting muscles in the foot of the *Meles vulgaris*. These agree with the above description, except in so far that they take origin on different planes.

Lutra vulgaris (Otter), (Pl. VIII. fig. 2).

Although the five digits of this foot are contained within a common web of integument, they nevertheless enjoy a wide range of movement, and in consequence the intrinsic muscles are well developed. In their arrangement they show a certain similarity to the same muscles in the Badger, but they approach much more closely the trilaminar disposition. Indeed, with one or two exceptions of minor importance, this foot may be said to meet all the requirements of the typical arrangement.

The plantar or adducting layer (p^1, p^2, p^5) corresponds in the number and character of its elements with that of the Badger. As in the tetradactylous Carnivora, however, an opponens minimi digiti (*o.m*) is developed in connection with the adductor of that toe. This muscle is inserted into the plantar face of the distal third of the fifth metatarsal bone.

The intermediate flexores breves (f^1 to f^5) show only a very slight tendency to fusion with the dorsal interossei. Each digit, with the exception of the hallux, is provided with a double-headed muscle. The flexor brevis hallucis, however, is represented by a single inner head.

The dorsal muscles (d^2 to d^5 and *a.o*) are arranged in a manner similar to those in the foot of the Badger, with the exception that we find a small abductor hallucis present, —quite separate from the inner head of the flexor brevis of that digit.

Mustela putorius (Pole-Cat).

With regard to the pes of the Pole-Cat, my observations do not extend beyond the adducting muscles. The animal was so putrid that a dissection of the deeper layers was impossible. I made out with certainty, however, that the adductors were identical both in point of number and mode of disposition with the corresponding muscles in the Otter and the Badger. Further, like the former, it possesses an opponens minimi digiti developed in the same way.

The plantigrade character of a foot has apparently no effect in regulating the relation which exists between the intrinsic muscles and the metatarsus. In the Badger the plantar position of these muscles is quite as well marked as it is in the Otter and other digitigrade Carnivora.

Trichechus rosmarus (Walrus), (Pl. XI. fig. 3).

The Walrus which I examined was a very young specimen, and one which had been preserved in spirit for a great number of years in the stores of the Edinburgh Anatomical Museum. The muscles, however, were in a remarkably good condition, and I experienced little difficulty in obtaining a satisfactory display of the intrinsic group. Dr. J. Murie in his elaborate series of papers upon the Anatomy of the Pinnipedia, published in the Transactions of the Zoological Society, devotes part 1 (vol. vii.) entirely to the Walrus, and he figures and describes the intrinsic pedal muscles (p. 456). In some points the specimen which I dissected differs from his description.

In the Walrus the intrinsic muscles of the pes are poorly developed, and in no respect proportionate in size to that of the foot. The dorsal and plantar layers are very meagrely represented. The intermediate layer, however, is almost complete as regards its number of elements.

Plantar layer.—The adductor hallucis is the only member of this layer which is present. It consists of two very distinct portions, viz., an adductor obliquus (p^1,o) and an adductor transversus (p^1,t). Both are narrow flat fleshy bands. The former arises from the plantar surface of the base of the fourth metatarsal bone, and the latter from the fascia covering the flexor brevis minimi digiti close to its insertion. The two heads coalesce upon the plantar aspect of the flexor brevis indicis, and a long narrow tendon emerges from the point of union. By this tendon the muscle is inserted into the extensor tendon upon the fibular aspect of the first phalanx of the hallux.

A slender fibrous band occupies the position of the adductor minimi digiti (p^5). It springs from the base of the fourth metatarsal bone, and is inserted upon the tibial side of the base of the first phalanx of the minimus.

Dr. Murie gives no description of these muscles in the text, but he figures (fig. 8, p. 456) two muscular slips and names them superficial layer of interosseous muscles. One of these has very much the same position as the adductor obliquus hallucis in my specimen, whilst the other occupies the place of the fibrous adductor minimi digiti. He represents both, as arising from the plantar surface of the middle metatarsal. The transverse head of the adductor hallucis is not figured at all.

Intermediate layer (f^1 to f^5).—Each digit is provided with a short flexor which, except in the case of the hallux, is two headed. The flexor brevis hallucis (f^1,f) has only a fibular head; the fibular head of the flexor brevis medii (f^3) is remarkable for its small size; and the two portions of the flexor brevis indicis (f^2) arise at some distance

from each other—the one from the base of the second and the other from the base of the first metatarsal bone. Dr. Murie names these muscles the double (or deep) interossei.

The dorsal layer.—The only elements of this layer which have retained their individuality are—

1. The abductor hallucis (d^1).
2. The abductor ossis metatarsi minimi digiti ($d^{6'}$).
3. The abductor minimi digiti (d^6).
4. The third dorsal interosseous muscle (d^4).

The abductor hallucis (d^1) arises from a sesamoid bone which glides upon the tibial side of the internal cuneiform. It is simply a strong rounded tendinous cord with a few muscular fibres at its proximal end, and it is inserted into the inner side of the base of the first phalanx of the hallux. Dr. Murie gives a different description of this muscle. He says:—"The presence of a muscle answering to one of these (*i.e.*, abductor hallucis) in the foot of the Walrus, manifests a commencing change on the adaptation of the pes as an instrument of clutch as well as support. The muscle in question has a long narrow belly, arising by a tendon from the extra bone outside the cuneiform, and is fleshy three-fourths of the length of the hallucial metacarpal (metatarsal?), being inserted by tendon and fascia into and over the metacarpo-phalangeal joint. Both in the Sea-lion and Seal, tendinous fascia takes the place of this muscle; but it is noteworthy that in *Ursus americanus* its representative is found." The almost completely fibrous condition of the muscle in my specimen associates it with the Seal, and may be accounted for by the youth of the animal.

The abductor ossis metatarsi minimi digiti ($d,6'$) exhibits the usual attachments.

The abductor minimi digiti (d^6) arises from the fascia covering the outer surface of the abductor ossis metatarsi minimi digiti, and is inserted into the outer side of the base of the first phalanx of the minimus.

The third dorsal interosseus is the only member of this group present as a distinct muscle. Not a trace of the remaining three dorsal interossei is to be observed, but as the outer head of the flexor brevis annularis and the inner head of the flexor brevis medii pass for a considerable distance upwards between the metatarsal bones, it is reasonable to suppose that they contain the fibres of the fourth and second members of this group. With regard to the first dorsal interosseus not even this clue, slight as it is, exists, for the inner head of the flexor brevis indicis is plantar in position.

In addition to the above intrinsic muscles two extra fleshy slips are found taking origin from the tarsal bones. The homology of these is somewhat difficult to determine. One ($d^6 \times$) arises from the under surface of the anterior border of the os calcis, and ends in a tendon which is inserted into the fibrous textures upon the plantar surface of the base

of the fifth metatarsal bone. The close association of this muscle, with the abductor ossis metatarsi minimi digiti seems to indicate that it is a development from the latter. Murie, however, points out with truth that if the fibrous structures into which it is inserted be raised (artifically) from the base of the fifth metatarsal, it passes uninterruptedly into the fleshy belly of the outer head of the flexor brevis minimi digiti—the two thus forming a digastric muscle. Upon these grounds he classes it with the short flexor of the minimus.

I am confirmed, however, in my opinion that this muscle is a third abductor of the minimus (which as we have seen is by no means an unusual occurrence) by a study of the corresponding muscle as exhibited in Dr. Murie's drawing of the intrinsic pedal muscles of *Otaria jubata* (Trans. Zool. Soc., vol. vii. pl. lxiii. fig. 38). In this animal the muscle gains an independent insertion into the outer side of the base of the first phalanx of the minimus. Dr. Murie terms it, "flexor brevis minimi digiti." Both heads of the short flexor, however, are likewise present, and these he names the "fifth double interosseus."

The second muscular bundle is very deeply placed, and lies obliquely in the sole (f^1t). It arises from the plantar surface of the middle cuneiform bone and tapering as it proceeds inwards joins the rounded tendon of the abductor hallucis about an inch and half from its origin. This muscle is evidently the inner head of the flexor brevis hallucis, displaced from its neighbour. Dr. Murie's account is somewhat different. He says, "The two short extra and deeply situated muscles met with in the sole of *Otaria jubata* are exactly similar in appearance and situation in *Trichechus rosmarus*. From position and attachments, though covered (and, indeed, entirely hidden), by the deep plantar fascia, they nevertheless may be the homologues of a double adductor hallucis, though it is still more likely that the tibial division is a flexor brevis hallucis, and the fibular one above an adductor." I cannot agree with Dr. Murie, in regarding either of these muscles as the adductor hallucis. The nerve supply shows this, if indeed any other evidence is necessary, beyond the presence of the true and undoubted adductor itself. In my specimen the muscle in question was single and supplied by the internal plantar nerve. Both slips I believe should be associated with the abductor hallucis, and inner head of the flexor brevis hallucis.

Nervous arrangements.—The abductor ossis metatarsi minimi digiti, and the muscular slip associated with it receive their nerve twigs from the trunk of the external plantar nerve (*e.p.n.*). The abductor minimi digiti is supplied by a branch from the superficial division of this nerve (*s.*). The deep division (*d.*) of the external plantar turns inwards under cover of the fibrous adductor minimi digiti and the adductor hallucis, and gives branches to all the intrinsic muscles, with the exception of the flexor brevis and the abductor hallucis. It ends in the substance of the inner head of the flexor brevis indicis. The outer head of the flexor brevis hallucis, the abductor hallucis, and the small deep belly representing the inner head of the flexor brevis hallucis are supplied by twigs

from the digital branch of the internal plantar nerve (*i.p.n.*), which is distributed to the adjacent sides of the index and hallux.

EDENTATA.

I have examined the feet of three members of this group, viz., the Tamandua, the Armadillo, and the three-toed Sloth. They all deviate from the typical arrangement, and the two last present certain features of great interest.

Myrmecophaga tamandua (Pl. VIII. figs. 5 and 6).

The foot of this animal is pentadactylous; and the toes are all of nearly equal length, and each is armed with a powerful curved claw. The three layers of intrinsic muscles are quite distinct, but there is a considerable reduction in the typical number of elements composing the flexor layer, and abduction and adduction of the digits is not effected with reference to the medius.

Plantar layer (figs. p^1, p^2, p^5).—Three muscles are found in this layer, viz.:—

1. The adductor hallucis (p^1).
2. The adductor indicis (p^2).
3. The adductor minimi digiti (p^5).

The adductor minimi digiti is a narrow muscular slip arising from the base of the fourth metatarsal bone and the sheath of the tendon of the peroneus longus, and inserted into the inner aspect of the base of the proximal phalanx of the minimus.

The adductor hallucis and adductor indicis are fan-shaped muscles, and they take origin in great part from a strong fibrous raphe which is attached by one end to the tibial side of the head and by the other extremity to the tibial side of the base of the fifth metatarsal bone. The adductor hallucis springs by its base from the proximal half of the inner border of this raphe, and also from the ligamentous textures over the bases of the third and fourth metatarsal bones. It is inserted upon the fibular side of the base of the first phalanx of the hallux. The adductor indicis arises from the distal half of the raphe, and has a narrow insertion into the fibular side of the base of the first phalanx of the index.

In the left foot (fig. 5, *p*) an additional adducting slip for the index was found. It took origin from the inner side of the base of the proximal phalanx of the minimus, and stretched transversely across roots of the annularis and medius to reach the index. This points to the tendency which any powerfully developed adducting muscle has to divide into an oblique and a transverse part. It is the result of the same process which is so strikingly seen in the adductor hallucis of Apes and Man.

These adducting muscles in the Tamandua, apparently act so as to approximate the toes towards the annularis. The medius, however, is not provided with a special adductor.

Intermediate layer.—The flexores breves, with the exception of those belonging to the marginal digits, are poorly developed. They can readily be distinguished from the dorsal interossei by their occupying a more plantar plane, and by their being altogether invisible from the dorsal aspect of the foot. The flexor brevis minimi digiti (figs. 5 and 6, f^5f and f^5t) has a powerful fibular head, which takes origin from the under surface of the cuboid, and a delicate tibial head which springs from the base of the fifth metatarsal bone.

The three succeeding short flexors (fig. 6, f^2, f^3, f^4) are one-headed muscles—each consisting of a delicate slip inserted upon the tibial side of the base of the annularis, medius, and index, respectively. In the left foot from which fig. 6 was taken, the flexor brevis annularis (f^4) was two-headed. The flexor brevis hallucis (f^1) is also merely represented by a tibial head, but this is strongly marked, and has a more proximal origin than its neighbours. It springs from the inner side of the ento-cuneiform bone.

Dorsal layer (figs. 5 and 6).—The muscles composing this layer are arranged (as in the case of the human foot) so as to abduct the toes from a line drawn through the index. They are—

1. The abductor hallucis (d^1).
2. The abductor minimi digiti (d^6).
3. The abductor ossis metatarsi minimi digiti (*a.o.*).
4. The dorsal interossei (d^2 to d^5).

The abductor hallucis has a wide origin from a cartilaginous process attached to the inner margin of the sole, and also from the plantar fascia. It is inserted into the inner sesamoid bone at the root of the hallux.

The abductor ossis metatarsi minimi digiti has the usual attachments. The abductor minimi digiti is a narrow muscle arising from the outer side of the tuber of the os calcis, and soon ending in a long slender tendon which is inserted into the outer sesamoid bone at the base of the minimus.

The dorsal interossei (fig. 6, d^2 to d^5) are four in number, one occupying each intermetatarsal space but not reaching forwards to the dorsum of the foot. They are powerful single-headed prismatic muscles, and are inserted so as to abduct the toes with reference to a line drawn through the index. The first and second dorsal interossei are, therefore, appropriated by this digit—one being inserted upon either side of the base of its first phalanx. The third is inserted upon the outer side of the base of the proximal phalanx of the medius, and the fourth upon the outer side of the base of the corresponding phalanx of the annularis.

There is, therefore, a very apparent want of correspondence in the arrangement of the adductors and abductors in Tamandua—the former acting towards the annularis, and the

latter towards the index. The flexores breves of the medius and annularis which are merely represented by tibial heads act no doubt like the first and second plantar interossei in man by antagonising the action of the third and fourth dorsal interossei. The index presents the anomaly of being provided with four intrinsic muscles, viz., (1) an adductor, (2) the tibial head of a flexor brevis (antagonistic to the adductor), and (3) two dorsal interossei (antagonistic to each other). So far as I am aware, this disposition of muscles is quite unique.

In Cuvier and Laurillard's plates[1] the abductor and the flexor brevis hallucis are alone figured (pl. cclxiii. fig. 1).

Rapp[2] merely describes the abductor minimi digiti, and states that the interossei lie in the intervals between the toes.

From a careful study of the account given by Professor Humphry[3] of the intrinsic muscles in the foot of the Manis (*Manis dalmani*), it seems to me that in their arrangement they closely resemble those of the Tamandua. Thus the plantar layer is composed of—(1) an adductor hallucis, (2) an adductor minimi digiti, (3) an adductor indicis, and (4) a transversus indicis, all of which are inserted in a similar manner to the corresponding muscles in Tamandua. These muscles Professor Humphry terms plantar interossei, and he classes with them two additional muscles, which he remarks are "situated on rather a deeper plane, nearer to the metatarsals, and pass, one to the fibular side of digit 3, and one to the fibular side of digit 4." These latter appear to me to be the fibular heads of the flexor brevis medii and flexor brevis annularis. With regard to the intermediate flexores breves it is evident that he includes three members of this group amongst the dorsal interossei, viz., the tibial head of the flexor brevis medii, the tibial head of the flexor brevis annularis, and the tibial head of the flexor brevis minimi digiti. This layer therefore, consists of—(1) a tibial head of the flexor brevis hallucis, (2) a two-headed flexor brevis medii, (3) a two-headed flexor brevis annularis, and (4) a two-headed flexor brevis minimi digiti. The dorsal layer thus reduced will consist of the same component parts as the corresponding layer in Tamandua, with the exception of the abductor ossis metatarsi minimi digiti, which is absent in Manis. Further, these muscles are inserted so as to abduct from a line drawn through the index.

The only essential difference between the intrinsic muscles in the foot of the Tamandua and of the Manis would appear to be in the disposition of the flexores breves. In the former each digit is supplied with a short flexor, but in the case of the minimus alone is this muscle two-headed; in the Manis the index has no flexor brevis, and the flexor brevis medii, the flexor brevis minimi digiti, and flexor brevis annularis are two-headed.

[1] Anatomie Comparée Recueil de Planches de Myologie.

[2] Anatomische Untersuchungen über die Edentata.

[3] The Myology of the Limbs of the Unau, the Aï, the two-toed Ant-eater, and the Pangolin, Jour. Anat. and Phys., vol. iv.

The intrinsic muscles of the foot in Tamandua derive their nerve supply in the usual manner, viz., the abductor hallucis and flexor brevis hallucis from the internal plantar nerve, and the other muscles from the external plantar nerve. The deep division of the external plantar nerve traverses the sole, between the plantar and intermediate layers of muscles (fig. 5, *e.p.n.*).

Dasypus sexcinctus (Pl. VIII. fig. 3).

The foot of this animal is of peculiar interest from the fact that, except in the case of the hallux and minimus, the intermediate flexors and the dorsal abductors have undergone regression, and are converted into fibrous tissue.

The plantar layer is well represented. It consists of four muscles, viz. :—

1. The adductor hallucis (p^1).
2. The adductor indicis (p^2).
3. The adductor annularis (p^4).
4. The adductor minimi digiti (p^5).

These are inserted so as to adduct the toes towards a line drawn through the medius. The first three arise by a common origin from the fibrous textures at the bases of the second and third metatarsal bones, and from this they diverge so as to reach their respective insertions. The adductor indicis has an additional head of origin from the base of the third metatarsal in common with the origin of the adductor annularis. This may represent a transversus indicis.

Intermediate layer.—Only two members of the intermediate group are present, viz., the flexor brevis hallucis (f^1f and t), and the flexor brevis minimi digiti (f^5).

The flexor brevis hallucis is well developed, and has the usual bicipital character. The tibial head (f^1t) is, however, to a certain extent fused with the abductor hallucis (d^1), and takes origin by a common tendon with this muscle, far back in the sole, from the ligaments in connection with the os calcis and astragalus. The outer or fibular head springs from the plantar surface of the ento-cuneiform, and both slips are inserted into the sesamoid bones at the base of the hallux.

The flexor brevis minimi digiti (f^5) is an exceedingly minute slip of muscular fibres, and can have little or no action upon the digit into which it is inserted.

The dorsal layer is composed of three muscles, viz., the abductor hallucis (d), the abductor minimi digiti (d), and the abductor ossis metatarsi minimi digiti (*o.m.*).

The abductor hallucis, as we have seen, to a certain extent fuses with the tibial head of the flexor brevis, and they both have a common origin from the astragalus and os calcis. They soon separate, however, and the abductor is inserted by a long narrow tendon into the tibial side of the ungual phalanx of the hallux.

The abductor minimi digiti and abductor ossis metatarsi arise from the os calcis. The

former is inserted by a long tendon into the fibular side of the distal phalanx of the minimus, whilst the latter is inserted into the base of the metatarsal bone of the same digit.

But the most remarkable feature in the pes of the *Dasypus sexcinctus* is that the place of the absent muscles is taken by fibrous bands (*f.b.*) which have precisely the same disposition and connections as those muscles of which they are the substitutes. These fibrous bands represent the fused flexores breves and dorsal interossei, and it is difficult to ascribe to them any function unless they act by preventing over-extension at the metatarso-phalangeal joints. The outer head of the flexor brevis indicis is not entirely transformed into fibrous tissue. Lying along its deep margin a fleshy slip of considerable size may be detected. From the manner in which the digits are bound together, they can have little power of independent movement, and this, no doubt, is the reason of the transformation of these intrinsic muscles into fibrous bands.

A very accurate account of the myology of the pes of this animal may be found in an able memoir by Mr. J. C. Galton.[1] I cannot agree with Mr. Galton, however, in the terms which he has applied to certain of the muscles. He looks upon the muscle which stretches between the os calcis and the base of the fifth metatarsal bone as being the abductor minimi digiti, and the muscle passing from the os calcis to the ungual phalanx of the minimus as being the flexor brevis. There can be little doubt that these muscles represent those after which I have named them, viz., the abductor ossis metatarsi and the abductor minimi digiti. The minute fasciculus (to which, by the way, he has affixed no name) appears to me to be the true flexor brevis minimi digiti.

But, again, he is of opinion that the adductor minimi digiti is the opponens. Such a conclusion I consider to be altogether untenable, as it is the very essence of an opponens that it should be inserted into the metatarsal bone, whilst this muscle is inserted into the distal phalanx.

The only discrepancies which exist between the above description of the intrinsic muscles in the foot of *Dasypus* and that given by Mr. Galton are: (1) he takes no notice of the fibular head of the flexor brevis hallucis which was very apparent in my specimen; and (2) he mentions an "interosseous" muscle going to the tibial side of the root of the index. This muscle was only present in the form of a fibrous band in the Armadillo I dissected, and it apparently represents the first dorsal interosseous muscle fused with the tibial head of the flexor brevis indicis.

Professor Macalister[2] mentions two muscles in *Dasypus* which in my specimen were merely represented by fibrous bands, viz., an abductor indicis or first dorsal interosseous muscle, and an abductor annularis or fourth dorsal interosseous muscle. It is a point of

[1] Linnean Transactions, vol. xxvi. pp. 562 and 563.

[2] Anatomy of *Chlamydophorus truncatus*, with notes on the structure of other species of Edentata, Transactions of the Royal Irish Academy, vol. xxv. p. 253.

great interest therefore to find that the transformed muscles in some cases assume their original condition. So far as I am aware no author has hitherto noticed these ligamentous bands in the foot of the Armadillo.

It is very unfortunate that Dr. Murie,[1] in his memoir upon the three-banded Armadillo, owing to a mishap which befell the feet, was able to give so little information upon the intrinsic muscles. He merely states that he was able to make out "strong interossei and other flexores breves. They were fewer in number than those specified by Galton in *Dasypus*."

In Cuvier and Laurillard's plates of the six-banded Armadillo the intrinsic muscles of the foot are not figured.

In the highly interesting memoir upon the limbs of the *Orycteropus capensis* by Mr. J. C. Galton[2] a series of fibrous bands are described in the foot which apparently represent missing elements of the intrinsic group of muscles. He describes each as being "a strong ligament which passes, forked at both extremities into a resemblance to an X, from the plantar aspect of the base of the metatarsal to the sesamoids, at the base of the proximal phalanx of each digit." They are confined to the three middle digits, and a reference to the beautiful figure (pl. xlvi. fig. 3) which accompanies this memoir, renders it apparent that they are transformed flexores breves. A fleshy short flexor for each of the remaining digits (viz., the minimus and hallux) is also present. Fibrous bands of a somewhat similar nature are likewise found in the manus of the same animal, and Mr. Galton calls them the "metacarpal ligaments."

Professor Humphry[3] in his paper upon the myology of the same animal makes no mention of these ligamentous slips.

Bradypus tridactylus (Pl. IX. figs. 2, 3, 4).

The remarkable hook-like character of the pes of the three-toed Sloth naturally suggests a corresponding peculiarity in the arrangement of the intrinsic pedal muscles. This we find to be the case. In this foot the index, medius, and annularis are alone fully developed. These are pressed tightly together, and enveloped by a common integumental covering, which reaches as far forward as the bases of the enormous claws. The digits possess therefore almost no power of independent movement. Further, the proximal phalanges of these toes are shortened to such an extent that they are merely represented by three square osseous nodules of little more than a quarter of an inch in length, which at an early age coalesce with the heads of the metatarsals, so as to render any movement at the metatarso-phalangeal joints impossible. The metatarsus is flanked on each side by a rudimentary metatarsal bone which supports no phalanges. These are rudiments of the hallux and minimus.

[1] The Three-banded Armadillo, Trans. Linnean Society, vol. xxx.

[2] The Myology of the Upper and Lower Extremities of *Orycteropus capensis*, Linnean Transactions, vol. xxvi. p. 567.

[3] On the Myology of *Orycteropus capensis* and *Phoca communis*, Jour. Anat. and Phys., vol. ii. pp. 305 and 317.

The primary office of intrinsic pedal muscles is to act upon the digits at the metatarso-phalangeal joints. In the Sloth, owing to the ankylosis of the first phalanges to the metatarsal bones, this function is abolished. Consequently, in the dissection of the sole not a vestige of an intrinsic muscle is to be found. The dorsal interossei, however, from their very common connection with the extensor tendons on the dorsal aspects of the digits, act secondarily (as Duchenne has pointed out) as extensors of the toes at the joints between the phalanges. In the Sloth these muscles are therefore retained upon the merits of this action. They have no action as abductors; they merely constitute accessory parts of the weak extensor apparatus on the dorsum of the foot, and must be studied in connection with the extensor brevis digitorum.

The extensor brevis digitorum (fig. 2, *fl br.d*) arises by two heads—one from the outer surface of the astragalus and os calcis, and the other from the dorsal aspect of the cuboid. These unite to form a flat ribbon-like muscle which ends in two tendons for the ungual phalanges of the index and medius respectively.

The dorsal interossei (fig. 2, d^2, d^3, d^4, d^5) are four in number, and constitute the only intrinsic muscles in this foot. The second (d^3) and third (d^4) are the most strongly developed, and they lie in the second and third inter-digital spaces. There they arise not only from the adjacent surfaces of the metatarsal bones but also from the sides of the proximal phalanges. The second, moreover, passes backwards for a considerable distance upon the dorsum of the tarsus. They both extend forwards as fleshy masses to the bases of the ungual phalanges, and here each divides into two portions. Two of these portions (viz., one from each muscle) are inserted into the dorsal aspect of the base of the third phalanx of the medius under cover of, and closely connected with, the tendon of the extensor brevis to this digit. An expansion is thus formed over the second phalangeal joint, which is fleshy at the margins where it is composed of fibres derived from the second and third dorsal interossei and tendinous in the centre where it is formed by the tendon of the extensor brevis. The inner part of the second dorsal interosseus is inserted in like manner, with the corresponding tendon of the extensor brevis into the dorsal aspect of the base of the ungual phalanx of the index. In this case, however, the expansion formed is fleshy only at its outer margin, and tendinous along its inner margin. The outer portion of the third dorsal interosseus is inserted in a similar manner into the ungual phalanx of the annularis. It is joined by the tendon of the fourth dorsal interosseous muscle.

The first dorsal interosseous muscle (d^2) is poorly developed in comparison with the preceding. It springs from the inner aspect of the rudimentary first metatarsal, and also from the dorsal surface of the base of the second metatarsal bone. It soon ends in a long narrow tendon which runs along the inner margin of the foot, to join the tendon of the extensor brevis for the index at the point where it merges into the dorsal expansion.

The fourth dorsal interosseous muscle (d^5) is also small. It takes origin in the interval between the rudimentary fifth and the fourth metatarsal bones, and almost immediately ends in a slender tendon which is inserted into the expansion formed by the outer part of the third dorsal interosseous muscle on the dorsum of the second phalangeal joint of the annularis.

But it may be asked, What has become of the other members of the intrinsic group of muscles? I believe that the adductors, and the marginal abductors are suppressed whilst the flexores breves have wandered to the dorsum of the foot and coalesced with the dorsal interossei. I have come to this conclusion, from an examination of the corresponding muscles in the manus of the same animal, and as the arrangement found in this is even more remarkable than that in the foot, I am induced to give a description of it (Pl. IX. figs. 3 and 4).

In general features the manus of the three-toed Sloth is very similar to the pes. The metacarpus and the phalanges resemble in almost every respect the corresponding bones of the foot. The intrinsic muscles, however, are not banished from the palm. There is a distinct palmar layer of adductors; rudiments also of the flexores breves are to be found.

Palmar layer (fig. 3, p^2 p^{2x} p^4).—This layer is composed of two muscles, viz., (1) the adductor annularis (p^4), and (2) the adductor indicis. These muscles are flat ribbon-shaped bands which cross each other in the palm like the limbs of the letter X.

The adductor annularis is the more superficial of the two. It arises from the bases of the first and second metacarpal bones, and extends obliquely across the palm to the inner margin of the hand, where it is inserted partly into the palmar face of the stunted first phalanx, and partly into the head of the metacarpal bone of the annular digit.

The adductor indicis is composed of an oblique ($p.\ 2\times$) and transverse part ($p.\ 2$). The former takes origin from the base of the fourth metacarpal bone, and extending obliquely towards the root of the index is inserted into the radial and palmar aspect of the first phalanx, and also into the head of the metacarpal bone of this digit. The transverse adductor is a small slip which springs from the palmar surface of the middle metacarpal bone, near its head, and stretches transversely from this towards the index where it joins the oblique adductor close to its insertion.[1]

As the digits have no more power of independent movement these adductors can have little or no action beyond bracing together the margins of the manus. That they are undergoing retrograde development is rendered likely from the fact that they are largely composed of tendinous fibres. It is probable, therefore, that these muscles in

[1] Although I have described these palmar muscles as adductors of the index and annularis from their insertions into these digits, I am rather of opinion that they represent the adductors of the absent hallux and minimus. This view would account for their palmar insertions.

the foot have disappeared by suppression, and that the adductors of the hand are following their example.

The *dorsal layer* (fig. 4, d^2 to d^5) is represented by four dorsal interossei. These are arranged in a manner almost identical with that of the same muscles of the foot with the exception that the tendons of the common extensor replace those of the extensor brevis in the formation of the two radial expansions on the dorsal aspect of the second phalangeal joints, and that the second dorsal interosseus muscle does not extend upwards upon the carpus, but is confined entirely to the second inter-digital interval.

In both hand and foot the proper extensor apparatus of the digits is exceedingly weak. In the former there are only two small tendons sent by the extensor communis, to the medius and index, and in the latter two equally small tendons are given by the extensor brevis to the same digits. The dorsal interossei however make up for this deficiency. The annular digit is entirely dependent upon this group of muscles for the production of this movement.

Intermediate layer (fig. 4 f^2 to f^5).—Under cover of the adductors we find five small muscles which without doubt represent the flexores breves. In this case, however, they possess no flexing action upon the digits, but are rather converted into extensors by being carried backwards through the interosseous spaces to join the dorsal interossei.

The flexor brevis pollicis consists of two very minute thread-like fasciculi which spring from the plantar aspect of the base of the rudimentary first metacarpal bone. They sink into the substance of the fibrous cord which prolongs this bone forwards, and in this way they gain an insertion into the radial aspect of the first phalanx of the index.

A small slip (f^3 *r*), evidently the radial head of the flexor brevis indicis, takes origin from the outer side of the base of the index metacarpal, and at once turns backwards through the first interosseous space to join the first dorsal interosseous muscle. The ulnar head of the same muscle (f^3u) arises from the inner side of the base of the same metacarpal, and inclines backwards in the second interosseous space, to join the second dorsal interosseous muscle. This slip is so closely connected with the interosseous muscle that at first sight it appears to be merely a part of it.

The short flexor of the medius has disappeared altogether.

The flexor brevis annularis (f^4) arises by two well-marked heads of which one springs from the outer side of the base of the fourth metacarpal bone, whilst the other, considerably longer, takes origin from the unciform bone. These soon unite, and the muscle is then directed through the third interosseous space to join the third dorsal interosseous muscle.

The flexor brevis minimi digiti (f^5) is a small fleshy belly which arises from the base of the rudimentary fifth metacarpal bone, and then passes backwards between it and the fourth metacarpal to effect a junction with the fourth dorsal interosseous muscle.

So far as could be made out all the intrinsic muscles of the hand were supplied by the deep division of the ulnar nerve (fig. 3, *d.u.n*). This passed outwards in the palm under cover of the adductor muscles.

The literature bearing upon the intrinsic muscles of the pes and manus of the *Bradypus tridactylus* is very plentiful, but somewhat conflicting.

Professor Macalister[1] in his paper upon the myology of this animal says:—"The short muscles of the hand are—abductor primi digiti, a short flat band passing from the scaphoid bone, and the annular ligament to the first phalanx of the inner digit; on raising this and the flexor tendons, I could see no traces whatever of palmar interossei. Extensor brevis digitorum manus, a small muscle on the back of the hand, which seems to contain the displaced germs of the dorsal interossei; its tendon joins the aponeurosis of the extensor digitorum longus, and is inserted along with it." From its connections it would seem that this abductor primi digiti is the muscle which I have named, the adductor annularis. Further, I believe that the extensor brevis manus is in reality the dorsal interossei.

Macintosh[2] gives the following account of the intrinsic muscles of the manus:—"Abductor annularis is bicipital, one head from the base of the germ of the inner metacarpal, and the other from the pisiform. Adductor annularis extends from the outer side of the carpus obliquely inwards to the distal end of the fourth metacarpal. . . . Adductor pollicis arises from the ulnar side of the base of the combined metacarpal, and is inserted into the base of the rudimentary thumb. The first and second palmar interossei, normal in our specimen and in Professor Humphry's, were absent in Professor Macalister's." Speaking of the foot he says:—"The muscles of the digits are abductor and adductor indicis and medii, all more or less fused; abductor annularis from rudimentary fifth metatarsal to the extensor tendon of the outer digit; adductor annularis from the fourth metatarsal to the same digit. The two plantar interossei send in two slips on the plantar aspect of the foot."

This description is somewhat difficult to follow. It appears, however, that whilst the dorsal interossei never alter in their arrangement, the vestiges of the flexores breves and adductors are subject to considerable variation. Thus they may be absent in the hand, as in Professor Macalister's specimen; present in both hand and foot as in Mr. Macintosh's specimen; or present in the hand and absent in the foot, as in my specimen.

In Professor Humphry's[3] account of these muscles which, in so far as the dorsal interossei are concerned, agrees in almost every respect with that which I have given, there is no mention of plantar or palmar muscles as distinct elements, but the author speaks of

[1] On the Myology of the *Bradypus tridactylus*, with Remarks upon the General Muscular Anatomy of the Edentata, Annals and Magazine of Natural History, vol. iv. p. 62.

[2] On the Myology of the Genus *Bradypus*, Proc. Roy. Irish Acad., vol. i. p. 524.

[3] Myology of the Limbs of the Unau, the Aï, the two-toed Ant-eater, and the Pangolin, Jour. Anat. and Phys., vol. iv.

the interossei as extending between the bones into the sole and into the palm. He appears to have had a very just conception as to the homology of these muscle extensions. In page 50 of his article he refers to them as flexores breves. He makes no mention of the adductors which were so apparent in the manus of the animal I dissected.

Cuvier and Laurillard figure the dorsal interossei in both the hand and foot of the three-toed Sloth (pl. cclii. fig. 1).

Ungulata.

The feet of the Horse, Ox, Sheep, Camel, and Pig are of great interest on account of the modifications which the intrinsic muscles have undergone to suit the requirements of the limb. In the first three of these animals the different steps by which the process has been brought about can be traced with great exactness.

Equus caballus (Horse), (Pl. IX. fig. 7, and Pl. XI. figs. 7 and 7*a*).

In the foot of the Horse, the middle digit is alone developed. It consists of a powerful metatarsal, succeeded by three phalanges. Rudiments of the second and third metatarsal bones are also present, but these do not extend so far down as the metatarso-phalangeal or fetlock joint, and they support no phalanges. Now this single digit of the horse is supplied with the three typical intrinsic muscles which usually belong to the medius or middle toe, viz.: the flexor brevis medii and the second and third dorsal interosseous muscles.

The flexor brevis medii (Pl. IX. fig. 7, f^3) is converted into fibrous tissue, and forms an exceedingly powerful ligamentous structure (nearly twice as thick as the tendo achillis of man) which is termed by veterinary anatomists the "suspensory ligament of the fetlock" or "ligamentum volare rectum ossium sesamoideorum superius." It lies upon the posterior surface of the large middle metatarsal bone, and is attached by its upper end to the plantar aspect of the base of this bone, and also to the lower tarsal bones. Inferiorly, it divides into two portions which, diverging from each other, embrace the metatarso-phalangeal or fetlock joint, and are inserted partly into the sesamoid bones on the plantar aspect of the base of the first phalanx and partly into the extensor tendon on the dorsal aspect of the same phalanx.

The transformation of this ligament into fibrous tissue, enables it to play a most important part in the mechanism of the limb. It prevents over extension at the fetlock joint, and its value in this respect is evidenced by the fact that in cases where it is ruptured, the animal becomes what, in veterinary language, is termed "broken down," *i.e.*, the fetlock joint sinks down and the hoof has a tendency to tilt forwards and upwards.

The most interesting point, however, in connection with this structure, is that it bears its history on its face. Almost invariably two thin streaks of striated muscular fibres are to be found on its superficial surface, leading down to its two inferior divisions.

Again, on examining its deep surface, two very distinct strands of pink fleshy tissue are always observed extending throughout the entire length of the ligament. These consist in each case of short oblique striated fibres, converging towards the middle line of the ligament. They represent those muscular fibres of the two heads of the flexor brevis which have not yet been converted into fibrous tissue.

On making a thin microscopic transverse section of the suspensory ligament, the muscular fibres are seen to sink deeply into its substance. Placing such a section against a black ground, and examining it with the naked eye, two very distinct crescentic outlines of transversely divided muscular fibres are observed embedded in the general mass of tendinous tissue (Pl. XI. fig. 7). Subjecting now the specimen to the microscopic test, we find that the outlines of muscular fibres are broken at intervals by quantities of fat cells, and amidst these we can detect, every here and there, transversely divided nerves and blood-vessels (Pl. XI. fig. 7, *a*). These crescentic outlines of a tissue so foreign to the intimate structure of a true ligament undoubtedly represent the remains of the two heads of the muscle from which the ligament is derived.

The muscular tissue is so small in amount in comparison with the bulk of the ligament that it can exercise no function whatever. To account for its existence, we must of course suppose that it receives twigs from the nerves which traverse the structure, and further, that it contracts; but it would be absurd to imagine that the contraction could be followed by any appreciable result.

Veterinary anatomists are quite familiar with the presence of these fleshy fibres. Gamgee and Law[1] state that the suspensory ligament has in most cases a few muscular fibres. Chauveaux[2] remarks that it often contains "fasciculi of fleshy fibres in its texture." Perhaps of all books on veterinary anatomy, Percival, in his work upon the Horse, gives the best account of the relation of these muscular fibres to the ligament. To quote his words:—"In composition and texture, this ligament possesses peculiarities, it has a sanguineous tinge interiorly, which is not perceptible in other ligaments or tendons, and its fibres, which are very coarse, are disposed in layers. But its chief peculiarity consists in its exhibiting an intertexture of delicate, pinky, fleshy fibres which seem to be the uniting medium of the ligamentous fasciculi."[3]

All are likewise agreed as to muscular derivation of the ligament, although there is considerable difference of opinion as to the actual muscles which have entered into its composition. George Stubbs,[4] writing so far as back as 1766, applies the term "interosseus" to the suspensory ligament, but considers it the representative of no less than five muscles. To use his own words, "it is of a ligamentous nature, but it supplies the places of the interosseus, the short flexor, adductor, and abductor of the great toe, the

[1] General and Descriptive Anatomy of the Domestic Animals, p. 277.
[2] Comparative Anatomy (translated by Fleming), p. 157.
[3] Anatomy of the Horse, p. 74.
[4] Anatomy of the Horse, Explanation to plate. xv.

abductor and short flexor proper to the little toe, and a ligament which arises from the calcaneum." Chauveaux [1] states that it corresponds to the two muscles, which in man, lie along side the interosseous metacarpal muscles. I am at a loss to understand the two muscles to which he refers. Gamgee and Law [2] are also somewhat vague. They remark that the interosseous muscle of the medius is "transformed into the suspensory ligament." Meckel in his "Traite Général d'Anatomie Comparée" (p. 443), asserts that this ligament is not only the representative of the interossei, but also of the lumbrical muscles. Two minute lumbricals, however, are present as independent muscles in the foot of the horse.[3] Professor W. H. Flower, in his recent article upon the "Zoology and Anatomy of the Horse," in the ninth edition of the Encyclopædia Britannica, vol. xii. p. 178, says:—"Its attachments and relations, as well as the occasional presence of muscular fibres in its substance, show that it is the homologue of the interosseous muscles of other mammals, curiously modified, both in structure and function to suit the requirements of the horse's foot."

The second (Pl. IX. fig. 7, d^3) and third dorsal interossei (Pl. IX. 7, d^4) are very rudimentary, and are placed one upon each side of the flexor brevis or suspensory ligament. Each muscle consists of a small fleshy belly, about two inches in length, succeeded by a long narrow delicate tendon. The second dorsal interosseus arises from the outer side of the base of the small second metatarsal bone, whilst the third springs from the inner side of the base of the rudimentary fourth metatarsal and each is inserted upon its own side of the fetlock joint, where it joins the band sent by the suspensory ligament to the extensor tendon on the dorsum of the first phalanx.

The dorsal interossei of the Horse, from their minute size, can exercise no abducting action upon the medius. They are merely vestiges, and point to retrograde development. Rigot considers that they have "the power of raising the synovial membranes of the pastern joint and sesamoid sheath during flexion" (*vide* Gamgee and Law, p. 413). A close study of their connections renders such an action very improbable.

The chief interest of these rudimentary interossei muscles centres in the fact that they constitute a link in the soft parts between the Horse of the present day, and its three-toed ancestor. They are undoubtedly vestiges of well developed interosseous muscles which lay in the second and third intermetatarsal spaces, and exercised the usual abducting action upon the middle digit. Occasionally they are found greatly enlarged. Thus in a Horse, which was dissected last winter session (1880–81) in Dick's Royal Veterinary College, Edinburgh, Mr. M'Fadyean, the Professor of Anatomy, informs me that the fleshy bellies of these muscles were several inches long and proportionately thick; indeed, each exceeded in size a strongly-marked plantaris muscle in man.

[1] Comparative Anatomy, Fleming's Translation, p. 154.
[2] *Loc. cit.*, p. 413.
[3] *Vide* Gamgee and Law, *loc. cit.*, p. 413; Chauveau's Comparative Anatomie, p. 311.

Veterinary anatomists rightly term these muscles "interossei," but they are in error, in so far that they consider them to be the interossei of the lateral digits, *i.e.*, the first and fourth dorsal interossei. These muscles have undoubtedly disappeared along with the digits to which they belonged.[1]

Bovidæ (Oxen).

In the Ox the two digits which are present represent the medius and annularis. The metatarsals corresponding to these toes are fused so as to constitute a single bone, the double constitution of which is marked (1) by a deep longitudinal furrow on its anterior surface, (2) by a slightly marked groove on its posterior aspect, and (3) by a notch on its inferior extremity which separates the two articular surfaces.

The suspensory ligament of the Ox shows its muscular origin in a still more striking manner than that of the Horse. It is an exceedingly powerful structure which rests upon the posterior face of the metatarsus; expanding somewhat as it descends, it divides opposite the junction of the middle and lower thirds of the fused metatarsal bones into five distinct portions; of these (1) two go to the annularis; (2) two to the medius; and (3) one passes forwards in the notch which separates the two articular surfaces on the lower end of the metatarsus. The slips which go to the digits, have in each instance precisely the same insertion. They are inserted one into each of the sesamoid bones at the base of the first phalanx, whilst the marginal slip on each side sends forwards a strong flat band to be attached to the extensor tendon on the dorsum of the first phalanx of the corresponding toe. The remaining slip which passes forwards is central in position, and it reaches the dorsum of the foot in the interval between the two first phalanges of the digits. Here it splits into two diverging portions which join the extensor tendons on the dorsal aspect of the toes.

The suspensory ligament has thus two distinct insertions on each side of each digit, viz., into the sesamoid and into the extensor tendon, and in this manner an extremely powerful brace is formed, which very efficiently prevents over-extension at the metatarso-phalangeal joints.

But this ligament has also two additional attachments of an altogether different nature. From the middle of its superficial or posterior surface, two thick rounded tendinous looking slips arise. These pass downwards and, joining the tendons of the perforatus, take part in the formation of the double ring through which the two tendons of the perforans pass.

[1] We may at this stage refer to the foot of the Tapir. In Dr. Murie's admirable paper upon the Malayan Species (Jour. Anat. and Phys., vol. p. 166) the intrinsic pedal muscles are described and figured so clearly that although he speaks of them simply as single and double interossei, there is no difficulty in recognising their homologies. In this foot the hallux and minimus are absent. The plantar layer is composed of two muscles, viz., (1) the adductor indicis, and (2) adductor annularis. The intermediate layer consists of a strongly marked two-headed flexor brevis appropriated to each digit. No members of the dorsal layer are present, but it is very probable that they have fused with the strongly marked short flexors.

In the suspensory ligament of the Ox there is a large amount of muscular tissue, not only on its surface but also embedded in its interior. On the lower half of its superficial surface we find a thick layer of fleshy fibres. This is even continued down for some distance upon the slips into which the ligament divides. But it is upon the deep surface of the suspensory ligament that we observe the greatest quantity of muscular tissue. Here it extends from the origin of the structure down to the point where it subdivides, and it is disposed in three parallel and longitudinal strands; of these (1) one passes down to the angle of divergence of the two slips for the sesamoids of the medius, (2) another to the angle of divergence of the slips for the sesamoids of the annularis, whilst (3) the third is carried downwards between the two preceding to the central slip, and this is much the most strongly marked; indeed, at the lower part of the ligament, it extends right through the structure to its posterior or superficial surface. Each strand consists of short fibres arranged in an irregularly bipenniform manner.

When thin transverse microscopic sections of this ligament are made, the muscular tissue is seen to penetrate deeply into its substance. It is arranged in the form of four small circles or rings, with thick outlines placed side by side, nearer the anterior than the posterior surface of the structure (Pl. XI. figs. 8 and 8*a*.) It is present in much larger quantity than in the case of the Horse. When examined under the microscope these transverse sections show a considerable number of fat cells associated with the muscular fibres, and amidst these transversely cut nerves and blood-vessels.

But we must endeavour to determine the intrinsic muscle or muscles from which the suspensory ligament of the Ox is derived. In this we are aided by the definite arrangement of the muscular fibres. In the Horse only one muscle, viz., the flexor brevis medii, enters into its formation; in the Ox we have clear proof of at least two muscles. Each muscular ring seen in the substance of the transversely divided ligament represents the head of a flexor brevis. The ligament is thus formed by the union and fibrous degeneration of both heads of the flexor brevis medii, and of the flexor brevis annularis. The central slip of attachment which passes forwards between the digits, simply represents a portion of the outer head of the flexor brevis medii, and of the inner head of the flexor brevis annularis, proceeding to obtain an insertion into the extensor tendons.

No evidence exists to show that any of the other intrinsic muscles which usually belong to the medius and annularis are contained in this ligament.

But it may be asked, what do those tendinous cords which join the tendons of the perforatus homologate? Are they adductors, or indeed have they any muscular origin at all? I feel confident that they have not. Even before they separate from the ligament they have an appearance as if they hardly belonged to it, but constitute a thick layer on its superficial surface distinct from, although united to the body of the structure. I believe that they are derivations from the dense fascia, which invariably covers the

intrinsic muscles of the foot. This view is very strongly supported, as we shall see, by an examination of the foot of the Sheep.

Ovis aries (Sheep).

The bony framework of the foot of the Sheep is the same as that of the Ox. A study of this pes places the fascial derivation of the strong tendinous slips, which are given by the suspensory ligament of the Ox to the perforatus tendons, beyond a doubt. The suspensory ligament of the Sheep is covered by a dense aponeurotic membrane which is attached on each side to the margin of the metatarsus. This aponeurosis has no anatomical union with the ligament; indeed the ligament glides freely under it. It therefore represents the deep layer of fascia which is spread over the intrinsic muscles in other animals, and which is so strongly marked in the Baboon, and many other Apes (*vide* Bischoff[1]). Inferiorly it joins the tendons of the perforatus, not in cord-like processes, but by a flat ribbon-like band. This is unquestionably the homologue of the slips which spring from the superficial aspect of the suspensory ligament of the Ox, and by its union with the perforatus the rings, through which the tendons of the perforans pass, are formed.

The suspensory ligament of the Sheep has the same connections as that of the Ox. Its division into slips, however, takes place somewhat nearer the metatarso-phalangeal joints. Not a trace of muscular tissue is to be seen upon its superficial surface. A narrow inspection of its deep surface shows three delicate and parallel white streaks running in the long axis of the ligament, and occupying the same position as the strands of muscular fibres in the ligament of the Ox. On making thin microscopic sections of the structure we observe, with the naked eye, four rings, each with a delicate white outline, lying side by side in the substance of the ligament, and situated nearer the deep than the superficial surface (Pl. XI. figs. 9 and 9*a*). Under the microscope these outlines are seen to consist simply of fat cells, with here and there minute blood-vessels and nerves in their midst. Not a vestige of muscular tissue can be detected. In the Sheep, therefore, the fibrous metamorphosis of the intrinsic muscles has reached a more complete stage than in either the Horse or the Ox. Further, the microscopic examination of all these ligaments, but more especially that of the Sheep, appears to indicate that the process is effected by the fatty degeneration of the muscle fibres, with a concurrent increase of the connective tissue elements of the muscle. In all cases the change is more complete upon the superficial surface, and the blood-vessels and nerves of the muscles concerned are retained. On the deep surface of the ligament we always find a quantity of soft fat which, in the case of the Horse and the Ox, is so completely incorporated with the muscular fibres that it is impossible to remove it unless we take away at the same time the fleshy tissue.

With regard to the muscles which enter into the formation of the suspensory ligament

[1] Beiträge zür Anatomie des *Hylobates leuciscus*, München, p. 24, 1870.

of the Sheep, we conclude from the four fatty rings which are seen in its substance on transverse section that they are the same as in the Ox, viz., (1) the two heads of the flexor brevis medii, and (2) the two heads of the flexor brevis annularis.

Camelus bactrianus (Camel).

The foot I examined was that of a very young specimen. The suspensory ligament presents the same attachments as in the case of the Sheep. It gives off no slips to the perforatus tendon as in the Ox, and inferiorly it is very much flattened from before backwards. Unfortunately the pes had been injected with gelatine and carmine before it came into my possession, so that all the minute blood-vessels of the sheath of the ligament were full. It was therefore impossible to make out with certainty whether any muscular fibres were present on the surface. From the appearance presented, however, by transverse sections when examined by means of the microscope I am inclined to think that the conversion of the two flexores breves into ligamentous tissue is in this case complete. The Ox, the Sheep, and the Camel, therefore, illustrate very well three distinct stages in the metamorphosis.

The suspensory ligament of the Elk also appears to contain a considerable quantity of muscular tissue in its constitution.

Professor Morrison Watson, and Dr. A. H. Young in their paper upon this animal (On the Anatomy of the Elk, *Alces malchis*, Linnean Society's Journal, Zoology, vol. xiv.) give the following account of the ligaments:—The interossei "are represented almost entirely by a ligament corresponding to the suspensory ligament of the fetlock in the Horse. It consists of a stout musculo-tendinous band, which extends along the whole length of the metatarsus. The muscular portion does not appear to be arranged in any definite manner. Above the metatarso-phalangeal articulation the band divides into three portions, a central and two lateral; the central portion, after being connected to the sesamoid bones in this region, is inserted into the bases of the first phalanges of the two anterior toes; the lateral portions pass one along the outer, and the other along the inner, side of the metatarso-phalangeal joints to terminate on the dorsal aspect of the second phalanges of the anterior toes, by uniting with the extensor tendons."

Sus scrofa (Pig).

In the Pig the medius and annularis are largely and equally developed. The minimus and the index (*i.e.*, the marginal toes), whilst they are complete as regards the number of their segments, are short in comparison with the two central digits. The hallux is represented merely by an exceedingly minute rudimentary metatarsal bone.

The medius and annularis are enveloped in a common sheath of integument, and the weight of the body rests solely upon them. They are quite incapable of any movement of abduction and adduction.

In the Pig's foot a suspensory ligament is derived from members of the intrinsic group of muscles; but in this case certain of the dorsal interossei are called into requisition.

Adducting or plantar layer.—This layer is represented by two well-marked muscles, viz.:—

(1) The adductor indicis. (2) The adductor minimi digiti.

These muscles arise by a common origin from the central part of the base of the metatarsus, and then diverge from each other to reach their insertions. The adductor indicis is inserted into the outer sesamoid at the base of the first phalanx of the index, and also into the extensor tendon; the adductor minimi digiti is inserted in the same manner upon the inner aspect of the base of the first phalanx of the little toe.

The deep division of the external plantar nerve disappears under cover of the adductor minimi digiti, and can be traced inwards under the two plantar muscles, as far as the flexor brevis indicis in which it ends. It supplies all the intrinsic muscles.

Intermediate layer.—Each digit has a flexor brevis, although in no case does this muscle consist of two fleshy heads.

The flexor brevis indicis is represented by a well-marked fusiform tibial head which springs from the plantar and inner aspect of the base of the second metatarsal bone, and is inserted by a long tendon into the inner margin of the extensor tendon on the dorsum of the first phalanx of the index. In veterinary books (Chauveax, and Gamgee and Law) this muscle is termed a lumbrical and erroneously described as springing from the perforans. The outer fibular head is present in the form of a slender fibrous cord which stretches from the fibrous textures on the base of the third metatarsal bone to the outer sesamoid of the index.

The flexor brevis medii is a thick fleshy muscle composed of coarse fasciculi, which represent the tibial head alone. It lies upon the plantar face of the third metatarsal, from the base of which it takes origin. Approaching the metatarso-phalangeal joint it ends in a round tendon which is inserted into the inner margin of the extensor tendon on the dorsum of the first phalanx of the medius. A strong fibrous cord extends from the base of the third metatarsal to the outer sesamoid at the base of the same digit. It is difficult to determine whether this represents the outer head of the flexor brevis medii or the third dorsal interosseus (which is also absent) or both.

In the case of the annularis it is the fibular or outer head of the flexor brevis, which is present, and it presents exactly the same appearance as the preceding muscle. It

arises from the base of the fourth metatarsal, and is inserted into the extensor tendon on the outer aspect of the base of the annular digit. The inner or tibial head is represented by a very delicate fibrous slip inserted into the inner sesamoid.

The flexor brevis medii and flexor brevis annularis, lie directly under cover of the two adductor muscles, and are separated from them by the deep divison of the external plantar nerve.

The fibular head of the flexor brevis minimi digiti is the sole representative of this muscle, and as it is traversed throughout its whole length by a tendinous intersection, it is in all probability in combination with the abductor minimi digiti, which is absent as an independent muscle. It arises from the ligamentous textures at the base of the metatarsus, and is inserted upon the outer side of the base of the first phalanx of the minimus partly into the sesamoid, and partly into the extensor tendon.

Dorsal layer—In the Pig's foot we find no muscle belonging to this layer. The second and fourth dorsal interossei are converted into powerful ligamentous flattened bands which lie concealed in the second and fourth inter-metatarsal spaces. The former is inserted upon the inner face of the base of the medius partly into the sesamoid, and partly into the extensor tendon, and the latter is inserted similarly upon the outer aspect of the base of the first phalanx of the annularis. It is possible that the fibrous cord inserted into the outer sesamoid of the medius may represent the third dorsal interosseous muscle, but of this there is no decided proof.

But to what does this disposition, and, in some cases transformation, of the intrinsic muscles point? The short marginal digits are alone capable of lateral movement. They alone, therefore, retain their adductors, whilst their flexores breves are placed in such a position that when acting alone they exercise an abducting influence, and when acting in unison with the adductors they produce flexion.

With regard to the largely-developed annularis and medius in which lateral movement is prohibited, the function of the muscles usually set aside for this purpose is changed. Functionally we may look at these two digits as in reality one, and the muscles are arranged in accordance with this. The dorsal interosseus on each side of this double digit is converted into a strong ligamentous band. These two bands together act in a manner exactly similar to the suspensory ligament of the Horse, Ox, or Sheep; they prevent over-extension at the metatarso-phalangeal joints. The fibrous band inserted into the outer sesamoid of the medius also contributes feebly to produce this effect.

Of the four fleshy bellies which typically represent the flexores breves of the medius and annularis only two are retained, viz., the marginal bellies (*i.e.*, outer head of flexor brevis annularis and inner head of flexor brevis medii), and these together act as a short flexor for the double digit.

HYRACOIDEA.

Hyrax capensis.

The foot of the Hyrax is tridactylous—the hallux and minimus being absent. Of the three remaining digits the index alone possesses the three typical intrinsic muscles, whilst the medius and annularis each want an abductor. The myology of this interesting animal has been very fully worked out by Messrs. Murie and Mivart.[1] Even the minute intrinsic pedal muscles have not escaped their notice. They make no attempt, however, to classify these muscles, but merely describe them as single and double interossei. Their description is so accurate and exact that, in so far as the attachments of the muscles are concerned, I have little to add.

Plantar layer.—This layer is composed of two muscles, viz., (1) adductor indicis, and (2) adductor annularis. By Murie and Mivart they are named the second and fourth single interosseous muscles. In the figure which illustrates their description these muscles are represented as arising far apart from each other, and as being on the same plane as the other muscles. This is not the case, because proximally they are in contact and superficial, and they only diverge as they are traced towards their insertions. The adductor indicis arises from the fibrous structures on the plantar surface of the scaphoid bone, and is inserted into the fibular aspect of the base of the first phalanx of the index. The adductor annularis springs from the ligamentous tissue on the under surface of the cuboid, and is inserted into the tibial side of the base of the first phalanx of the annularis.

Intermediate layer.—Each digit is provided with a two-headed flexor brevis which lies upon the plantar aspect of the corresponding metatarsal bone, and has the usual connections; these muscles are termed by Murie and Mivart the double interossei.

Dorsal layer.—This group is only partially represented, the first and second dorsal interossei alone are present (first and third single interossei of Murie and Mivart).

The first dorsal interosseus or abductor indicis is a powerful muscle which arises from the inner and dorsal surface of the second metatarsal bone in its proximal half, and is inserted into the tibial side of the base of the first phalanx of the index.

The second dorsal interosseous muscle is not so strongly marked. It arises from the plantar aspect of the base of the middle metatarsal bone under cover of the adductor indicis, and is inserted into the inner aspect of the base of the first phalanx of the medius.

No trace of the two absent dorsal interosseous muscles is to be found. In all probability the third has coalesced with the outer head of the flexor brevis medii, and the fourth with the outer head of the flexor brevis annularis.

Messrs. Murie and Mivart noticed in their specimen muscular fibres arising from a ligamentous fascia upon the outer surface of the os calcis, and inserted into the head of the

[1] Proceedings of the Zoological Society of London, 1865, pp. 351, 352, 353.

fourth metatarsal, and they hint that this may possibly represent the abductor ossis metatarsi minimi digiti transferred in this instance to the annular digit. In the Hyrax which I examined I observed the thick ligamentous fascia upon the os calcis, but I could detect no muscular fibres in connection with it. I should imagine that this fascia, and the muscular fibres when they exist, undoubtedly represent that muscle undergoing retrograde changes.

Nervous arrangements.—The foot of the Hyrax presents one of the few instances in which we find a deviation from the usual and typical plan of nerve supply. The internal plantar nerve gives off a deep branch which sinks into the sole between those tendons of the flexor longus digitorum which go to the index and medius; after supplying twigs to all the intrinsic muscles of the index, this branch pierces the adductor indicis and ends in branches to the second dorsal interosseous muscle. The external plantar sends off a very minute deep division, which gives twigs to the flexor brevis annularis, and then dips under cover of the adductor annularis which it supplies.

Although I made a dissection of both feet of the specimen, I was unable to make out with precision the nerve-supply of the flexor brevis medii.

In dissecting the manus I was much interested to find that the same peculiarity in the nerve arrangements existed there. The median nerve supplies the muscles of the index, and ends in the outer head of the flexor brevis medii. The ulnar nerve supplies the muscles of the minimus and annularis.

The second dorsal interosseous muscle, which is supplied by the internal plantar in the foot, is absent in the hand. The fact of the outer head of the flexor brevis medii of the hand being supplied by the median may simply indicate that it contains in its midst the fibres of this lost interosseous muscle. In the manus, therefore, no less than in the foot, I am still doubtful as to the nerve supply of the short flexor of the middle digit.

Proboscidea.

Elephas indicus (Pl. XI. fig. 4).

Through the kindness of Professor Turner I have been able to examine the feet of a fœtal Indian Elephant, which has been preserved in spirit in the stores of the Anatomical Museum of the Edinburgh University for a great number of years.[1] The results I have obtained differ very slightly from those described by Messrs. Miall and Greenwood in their exhaustive paper upon the Anatomy of the Indian Elephant.[2]

In the disposition of its intrinsic muscles the foot of the Elephant is peculiar on account of the absence of the greater number of the plantar adducting and the dorsal abducting muscles. Encased as the digits are in the tough integument and the thick

[1] This specimen was described and figured by Professor Turner in the Jour. Anat. and Phys., July 1881.

[2] Journal of Anatomy and Physiology, vol. xii. pp. 286 and 287.

plantar cushion, they have little or no space wherein they can be separated and approximated, and consequently such muscles, had they been present, would have been almost functionless. Another remarkable feature in the foot of this animal is its resemblance to that of the Hyrax in the manner in which the intrinsic muscles derive their nerve supply. The intrinsic pedal muscles are entirely plantar in position.

The *plantar layer* consists of a single minute muscle—a transverse adductor of the index—which we may term the transversus indicis (p^2. *t*). This muscular slip arises from the head of the fourth metatarsal bone and the fascia covering the flexor brevis annularis, and passes transversely inwards upon the surface of the flexor brevis medii to be inserted into the fibular side of the sesamoid of the index.

Miall and Greenwood describe also an oblique adductor of the index which they term a "plantar interosseus." According to these authors this muscle "arises from the tarsus, opposite the bases of the third and fourth metatarsals, and is inserted into the fibular side of the base of the second digit." No such muscle existed in the fœtus dissected by me, but there was a strong fibrous band having precisely the same attachments, which I have no doubt is its representative (p^2).

Intermediate layer.—This is the only group of intrinsic muscles which is well developed. Each digit, with the exception of the hallux, is provided with a well-marked flexor brevis. These muscles are termed dorsal interossei by Miall and Greenwood.

The flexor brevis indicis (f^2) is the best marked muscle of the series. It consists of two heads, which arise from the fibrous textures in relation to the tendon of the peroneus longus, and are inserted one into each of the sesamoids on the plantar aspect of the base of the first phalanx of the index.

The flexor brevis medii (f^3) is also strongly marked, and composed of two heads which arise from the base of the middle metatarsal bone. The inner head also derives numerous fibres of origin from the fibular side of the fibrous cord which represents the oblique adductor indicis. The muscle is inserted in the usual manner into the sesamoids at the base of the medius.

The flexor brevis annularis (f^4) is more feebly developed. Its two heads are scarcely differentiated from each other, and its fibular slip passes for a short distance forwards into the fourth intermetatarsal space, which suggests the idea that combined with it is the absent fourth dorsal interosseous muscle. Like the preceding muscle it arises from the base of the fourth metatarsal, and is inserted into the sesamoids at the root of the annularis.

The flexor brevis minimi digiti consists of a single well-marked tibial head (f^5. *t*). From its taking a more proximal origin and from the stunted character of the metatarsal bone of the minimus this muscle does not lie in series with the other members of the group. Indeed, at first sight it is apt to be mistaken for an adductor, and Miall and Greenwood have described it as such. The fact, however, that all the deep branches of

the external plantar nerve run superficial to it points to its real nature. It arises from the under surface of the os calcis and from the calcaneo-cuboid ligament, and is inserted into the inner sesamoid bone of the minimus.

Dorsal layer.—This layer is composed of a strongly developed abductor minimi digiti, and the vestige of an abductor ossis metatarsi minimi digiti.

The abductor minimi digiti (d^6) is the largest of all the intrinsic muscles, and it has an unusual plantar position on account of the minimus being pushed inwards so as to lie in a plane posterior to the annularis. It arises from the under and anterior aspect of the tuber of the os calcis, and is inserted into the outer sesamoid of the minimus.

Abductor ossis metatarsi minimi digiti.—On the outer surface of the os calcis there is a dense fibrous band containing a number of muscular fibres; these do not extend so far forward as the fifth metatarsal bone. There can be little doubt but that they represent this muscle.

In the fœtus I examined the hallux was destitute of intrinsic muscles. In the specimen dissected by Miall and Greenwood there was a small flexor brevis hallucis.

Nerve-supply of the intrinsic muscles.—As in the case of the hyrax the internal plantar nerve (*i.p.n*) gives off a deep branch. This proceeds from the digital nerve, which divides to supply the contiguous sides of the medius and index. It is a twig of some size, and sinks into the sole to supply both heads of the flexor brevis indicis, and effect a junction with one of the deep branches of the external plantar nerve.

The external plantar nerve (*e.p.n*) sends off three deep branches which break up to supply the flexor brevis medii, the flexor brevis annularis, and the flexor brevis minimi digiti. The lowest of these twigs hooks round the transversus indicis, and supplying it with one or two small filaments communicates with the deep branch of the internal plantar. The abductor minimi digiti draws its nerve-supply direct from the trunk of the external plantar nerve.

Rodentia.

Lepus timidus (Hare), (Pl. XI. fig. 10).

The four outer toes of this foot are well developed, but the hallux is absent. The intrinsic muscles are so completely plantar in position that they are quite invisible from the dorsal aspect of the foot. The dorsal layer of muscles is not represented in this foot, and the plantar muscles are very feebly developed, and are evidently undergoing retrograde changes.

Plantar layer.—Two very minute muscular slips are the only representatives of this layer. They are (1) the adductor minimi digiti (p^5), and (2) the adductor indicis [1] (p^2).

[1] St. George Mivart and Murie, in speaking of the intrinsic muscles in the foot of the Hare, do not mention these adducting muscles. (Anatomy of the Crested Agonti, Proc. Zool. Soc., 1866, p. 415).

The adductor indicis (p^2) is the smaller of the two, and is very apt to be overlooked. They both arise by a common origin in the middle line of the foot from the ligamentous structures on the plantar aspect of the tarsus, and superficial to the other intrinsic muscles. Diverging from each other, they end in thread-like tendons which are inserted respectively upon the inner side of the base of the first phalanx of the minimus, and upon the outer aspect of the base of the same phalanx of the index. In both cases the insertion is into the extensor tendon and dorsal to that of the corresponding flexor brevis.

Intermediate layer (f^2 to f^5).—The members of this layer are strongly marked. On each metatarsal bone there is a powerful fleshy mass which, as it approaches the root of the corresponding toe, divides into two heads. These embrace the root of the digit, and are inserted partly into the sesamoids, and partly into the extensor tendon.

Dorsal layer.—Not a trace of abducting muscles is to be discovered. They are entirely lost. At the same time I am inclined to believe that they have coalesced with the flexores breves. It is true that there is very little outward evidence of this, only in fact, the presence of tendinous intersections traversing certain of the bellies of the flexores breves in lines along which such a fusion would take place.

Nerve arrangements.—The deep division of the external plantar nerve passes inwards under cover of the adductors, and supplies all the intrinsic muscles.

Bathyergus capensis (Pl. VIII. fig. 1) *and Mus capensis.* (Cape Mole and Cape Mouse).

The feet of these two animals are pentadactylous, and the intrinsic muscles are arranged upon identically the same plan in both. There is a total absence of the plantar adducting and the dorsal abducting muscles. The intermediate flexores breves, however are well developed, each consisting of two strong slips.

Whether the plantar and dorsal muscles are absent from suppression or fusion with the flexores breves it is impossible to make out. If it be due to the latter cause there are certainly no traces of the fusion to be discovered.

In both animals the same peculiarity in the arrangement of the intrinsic muscles of the hand is to be observed.

Castor fiber (Beaver).

The specimen of this species which I had an opportunity of examining was in a very putrid condition, but by a careful dissection of both feet I obtained a satisfactory view of the intrinsic muscles and their nerves of supply. There is a marked deficiency in the number of elements composing each of the three typical layers of pedal muscles, but those which are lost are for the most part represented in the foot by fibrous bands. The nerves have a very remarkable disposition.

Plantar layer.—The only muscular element of this layer is the adductor hallucis. It consists of a very minute short fleshy belly succeeded by a long slender fibrous band or

tendon. It springs from the fibrous structures on the deep surface of the middle cuneiform bone, and is inserted upon the outer aspect of the base of the first phalanx of the hallux. The adductor annularis is present in the form of a distinct fibrous band which rises from the tarsus beside the preceding, and is inserted upon the inner aspect of the base of the first phalanx of the annular digit. It contains no muscular fibres. Its position and connections alone tell its history.

Intermediate layer.—The three middle digits (*i.e.* index, medius, and annularis) are each provided with a well-marked and two-headed flexor brevis, which exhibits the usual connections. An aponeurotic band occupies the place of the inner head of the flexor brevis hallucis, whilst the outer head of the flexor brevis minimi digiti is represented by a slender fibrous cord. In the former a few fleshy fibres may be detected close to its origin.

Dorsal layer.—In this group we find—

1. An abductor hallucis. 2. Two dorsal interossei.
3. An abductor minimi digiti.

The abductor hallucis is a well-developed muscle which arises from the inner and under surface of the internal cuneiform bone, and is inserted into the inner sesamoid at the base of the hallux.

The first and second dorsal interossei are also well marked and present the usual insertions (viz., into the inner side of the base of the index and the outer side of the base of the medius respectively). They are single-headed muscles, and quite distinct from the flexores breves of these digits although closely applied to them.

A strong fibrous cord connects the shaft of the second metatarsal bone with the inner sesamoid of the medius. This may represent the second dorsal interosseus. Again, a strand of tough connective tissue which is attached by one extremity to the plantar aspect of the base of the fourth metatarsal bone and by the other to the outer sesamoid of the annularis may represent the fourth dorsal interosseus.

The abductor minimi digiti is a very feeble muscle.

Nervous arrangements.—In the foot of the Beaver there is very marked departure from the ordinary and typical distribution of nerves to the intrinsic muscles.

The internal plantar nerve divides into the usual four digital branches viz., (1), for the inner side of hallux, (2) for the adjacent sides of hallux and index, (3) for the adjoining sides of the index and medius, and (4) for the contiguous margins of the medius and annularis. From these, three muscular branches proceed for the supply of the intrinsic muscles. The first comes from the digital nerve to the inner side of the hallux and supplies the abductor hallucis. The second is the largest of the three, and takes origin from the third digital nerve. It sinks into the sole in the interval between the long flexor tendons which go to the index and medius, and breaks up into twigs which spread out to supply the adductor hallucis, the first dorsal interosseus, the flexor brevis indicis,

and the inner head of the flexor brevis medii. The third muscular branch springs from the fourth digital nerve and dips into the sole between those tendons of the flexor longus digitorum which go to the medius and annularis. It is destined for the supply of the flexor brevis medii—to both heads of which it gives filaments—and the third dorsal interosseus, but it likewise communicates on the one hand with the second muscular branch of the internal plantar and on the other with the terminal filament of the deep division of the external plantar nerve.

The deep division of the external plantar nerve is a very small twig, and ends in the flexor brevis annularis. The abductor minimi digiti is supplied by the superficial division of this nerve.

Cœlogenys paca (the Paca).

The foot of this rodent is pentadactylous. The hallux, however, is very rudimentary and the minimus is much smaller than the three central toes, which are nearly of an equal length. The plantar and intermediate layers of intrinsic pedal muscles in this animal are well represented. The dorsal layer is very deficient.

Plantar layer.—In this group there are three muscles, viz. :—

1. Adductor hallucis. 2. Adductor indicis. 3. Adductor minimi digiti.

They all arise by a common origin from the middle of the plantar surface of the tarsus, and, separating, they radiate from each other to reach their insertions. The adductor hallucis is inserted into the extensor tendon upon the outer side of the base of the hallux; the adductor indicis into the extensor tendon upon the same aspect of the base of the index; and the adductor minimi digiti into the extensor tendon upon the inner aspect of the base of the first phalanx of the minimus.

Intermediate layer.—As in the Beaver, the index, medius, and annularis have each a two-headed flexor brevis. This muscle springs from the base of the corresponding metatarsal, and its two heads, embracing the root of the toe with which it is connected, are inserted partly into the sesamoid and partly into the extensor tendon.

The flexor brevis minimi digiti has only a fibular head. This is a stout, fleshy belly which springs from the under surface of the external cuneiform bone, and is inserted into the outer sesamoid of the minimus.

The flexor brevis hallucis is represented by a tibial head which is much smaller than the preceding muscle. It arises from the under surface of the scaphoid, and is inserted upon the inner side of the first phalanx of the hallux.

Dorsal layer.—This layer is poorly developed. It has the following components :—

1. The abductor hallucis.
2. The second and fourth dorsal interossei.
3. The abductor ossis metatarsi minimi digiti.

The abductor hallucis is exceedingly small and closely applied to the tibial head of the flexor brevis hallucis. In great part fibrous, it arises from the scaphoid, and is inserted upon the inner side of the nodular first phalanx of the hallux.

The second and fourth dorsal interossei are strong, single-headed muscles which act as abductors of the index and annularis from the middle toe. There is no trace to be found of the other two interosseous muscles.

The abductor ossis metatarsi minimi digiti hardly deserves the name of a muscle. It is merely a stout fibrous band with an admixture of fleshy fibres which presents the attachments of this muscle.

Nervous arrangements.—The intrinsic muscles are supplied in the usual manner—the abductor and flexor brevis hallucis by the internal plantar nerve; the others by the external plantar. It is to be noted that the deep division of the latter nerve crosses the foot subjacent to the plantar muscles, and that it gives off the digital branch for the adjacent sides of the annularis and minimus. This branch reaches its destination by emerging from under cover of the adductor minimi digiti.

A comparison of the feet of the foregoing members of the Rodent order shows what seems to be a tendency to the disappearance of the plantar and dorsal muscles, but a retention of the intermediate muscles. The following table renders this evident :—

Plantar layer.

Paca	Three strongly developed adductors.
Hare,	Two feeble adductors.
Beaver,	One very weak adductor (with traces of a second).
Bathyergus, Cape Mouse,	None.

Dorsal layer.

Paca,	Four members of this group (two very weak).
Beaver,	Four members of this group (one very weak).
Hare, *Bathyergus*, Cape Mouse,	None.

Intermediate layer.

Cape Mouse, *Bathyergus*, Paca,	Five members of this group.
Hare,	Four members of this group.
Beaver,	Three members of this group (with traces of two others).

Further, according to St. George Mivart and Murie,[1] we may class with the *Bathy-*

[1] On the Anatomy of the Crested Agouti (Proc. Zool. Soc. Lond., 1866, p. 415).

ergus and Cape Mouse the Crested Agonti and the Guinea Pig, in both of which flexores breves are alone developed.

CHEIROPTERA.

Pteropus (Fox-bat), (Pl. XI. figs. 1 and 2).

The foot of the Fox-bat is pentadactylous—the four outer toes being of nearly equal length, and the hallux slightly smaller. All the digits are armed with sharp curved claws. The intrinsic muscles are well marked, but the dorsal or abducting members of the group, with one exception, are absent. They are all placed upon the plantar aspect of the metatarsus, and are all but invisible from the dorsal aspect of the foot.

Plantar layer.—Only two muscles of this layer are represented, viz.:—

1. Adductor hallucis (p^1).
2. Adductor minimi digiti (p^5).

These muscles together form a thin triangular sheet of muscular fibres spread out upon the flexores breves, but separated from them by the deep division of the external plantar nerve (*d.d*). This muscular sheet arises by its apex from the plantar surface of the tarsus somewhat nearer the inner than the outer margin of the foot, and it is mapped out into the two adducting muscles by a distinct fibrous raphe which extends from the apex to the base. The distal end of the raphe is not attached, and ends close to the inner side of the root of the medius. The adductor minimi digiti is much the larger of the two muscles, and is inserted into the inner sesamoid at the base of the first phalanx of the minimus. The adductor hallucis, small in proportion to the preceding, is inserted into the outer sesamoid at the base of the first phalanx of the hallux.

Intermediate layer.—This layer is typically complete (f^1 to f^5). A flexor brevis is provided for each digit; each muscle consists of two heads, and these are separate throughout their entire length. This group therefore is composed of eight distinct muscular slips, all of which lie upon the same plane. They arise from the fibrous textures at the base of the metatarsus and are inserted into the sesamoid bones alone.

The outer head of the flexor brevis minimi digiti, and the inner head of the flexor brevis hallucis, are considerably larger than the others. This increase in bulk may be due to their having coalesced with the absent abductor minimi digiti, and abductor hallucis.

Dorsal layer.—The only member of this layer which is present is the abductor ossis metatarsi minimi digiti (d^6). It is well developed, and has the usual connections. Not a trace of the dorsal interossei is to be found.

Nervous arrangements.—The posterior tibial nerve divides into its two terminal branches in the hollow of the os calcis.

The internal plantar nerve (*i.p.n*) on entering the sole at once breaks up into four digital branches :—These are distributed as follows :—(1) the innermost goes to the inner side of the hallux and gives three minute twigs to the large inner head of the flexor brevis hallucis ; (2) the next divides to supply the adjoining margins of the hallux and index, and gives a muscular twig to the first lumbrical ; (3) the third bifurcates and supplies the adjacent borders of the index and medius, and furnishes a filament to the second lumbrical ; (4) the fourth in like manner supplies the contiguous sides of the medius and annularis, and gives a twig to the third lumbrical. From the trunk of the internal plantar, before it breaks up into its digital branches, a few filaments are furnished to the flexor brevis digitorum.

The external plantar nerve (*e.p.n*) turns outwards under cover of the flexor brevis digitorum, and after supplying the abductor ossis metatarsi minimi digiti with one or two twigs divides into its superficial and deep divisions. The superficial part ends in two digital branches, of which one goes to the outer side of the minimus, whilst the other bifurcates to supply the adjacent borders of the minimus and annularis. The latter gives a twig to the fourth lumbrical which enters its plantar surface, and it is to be noted that in passing to its distribution it lies superficial to the flexor tendons and lumbricals. The deep part of the nerve turns inwards upon the flexores breves and under cover of the adductors, and reaching the inner margin of the sole it ends in the substance of the outer head of the flexor brevis hallucis. In addition to this, it supplies twigs to the adductors and to both heads of each of the four outer flexores breves.

There are two points in which this arrangement of the nerves is peculiar, viz. : (1) in the two outer lumbricals receiving their nerve supply upon their superficial aspect, and in the nerve to the third coming from the internal plantar ; (2) in the outer head of the flexor brevis hallucis receiving its nerve supply from the deep part of the external plantar.

I am quite aware that it may be objected that this muscle is not the outer head of the flexor brevis hallucis, but the oblique adductor hallucis. In answer to this I can only state that the muscular slip in question lies in series with the other flexores breves ; that in fact it is a flexor brevis in every respect except its peculiar nerve supply. It is further to be remembered that a large fan-shaped adductor hallucis is present, superficial to the short flexores (p^1).

Quadrumana.

Of this order of Mammalia I have only examined the feet of a Lemur, of a New Guinea Baboon (*Cynecophalus sphinx*), and of a large Monkey of which I merely possessed the partially skinned foot, and therefore could not determine with certainty the species. I believe, however, that it had been taken from a specimen of *Ateles*. The

vast amount of information which has already been furnished upon the anatomy of this order rendered further investigations on my part unnecessary. Professor Bischoff[1] of Munich, who is perhaps the greatest living authority upon the structure of the Ape, and its relation to that of Man, has added greatly to our knowledge in this respect, and so also have Huxley,[2] Duvernoy,[3] Vrolik,[4] Halford,[5] Macalister,[6] Champenys,[7] Ruge,[8] Murie and Mivart,[9] and many others. Except in the case of the three specimens, above quoted, the following facts are borrowed from the writings of these distinguished authors.

I have found the memoirs mentioned below especially useful in the present research. I regret, however, that I have not had an opportunity of studying Professor Halford's papers, and have thus been obliged to trust for my information regarding them to other memoirs in which they are noticed.

Plantar layer.—In the Quadrumana the adducting apparatus of the digits is usually very powerful, and further, it is plantar in position. Owing to the wide range of movement which is possessed by the opposable hallux, the adductor hallucis is developed to an extent far beyond the adductors of the other toes. It is in this group of animals that we observe for the first time a decided tendency in this muscle to split up into two parts, viz., an adductor obliquus hallucis, and an adductor transversus hallucis (*i.e.*, the transversalis pedis). Throughout Mammalia we occasionally see traces of a transverse adductor in connection with one or other of the muscles belonging to the plantar layer, but these are few in number, and the instances in which they occur have little direct bearing upon each other. In the Tamandua, Sloth, Elephant, and apparently also in the Armadillo, a transverse adductor of the index has been observed; again, in the Walrus a transverse adductor hallucis is present, and as we have noted, both Meckel and Ruge also consider the adductor hallucis in the Virginian Opossum to be double.

Bischoff in his memoir upon the *Hylobates leuciscus* gives an admirable account of the adductor hallucis in a great number of Apes. He shows that in the Gorilla, *Hylobates leuciscus*,[10] *Cynocephalus maimon*, *Cercopithecus sabäus*, and *Macacus cynomolgus* the two heads of this muscle are present as separate and distinct elements, whilst in the Orang,[11]

[1] Beiträge zur Anatomie des *Hylobates leuciscus*, München, 1870; Beiträge zur Anatomie des Gorilla, München, 1879.

[2] Structure and Classification of Mammalia (Lectures delivered before the Royal College of Surgeons), Medical Times and Gazette, 1864.

[3] Des caractères anatomiques des grands singes pseudo-anthropomorphes, Archives du Museum, tom. viii.

[4] Recherches d'Anatomie sur le Chimpansé, 1841.

[5] Not like Man, Bimanous, and Biped, nor yet Quadrumanous, but Cheiropodous, Melbourne, 1863; Lines of Demarcation between Man, Gorilla, and Macaque. Melbourne, 1864.

[6] Article on the Gorilla, Proc. Roy. Irish Academy, vol. i., ser. ii. pp. 501 and 504.

[7] On the Muscles and Nerves of a Chimpanzee and a *Cynocephalus anubis*, Journal of Anatomy and Physiology, vol. vi. pp. 187 and 203.

[8] Zur vergleichenden Anatomie der tiefen Muskeln in der Fussohle, Morph. Jahr., 1880.

[9] Anatomy of the Lemuroidea, Transactions of the Zoological Society, vol. xii.

[10] In the text (p. 39) the author states that in *Hylobates* the two muscles are coalesced, whilst in the table at the end of the work he says that they are "beide getrennt und stark."

[11] Bischoff asserts that the two heads are separate. Ruge, however, figures the muscle as a single fleshy mass (fig. 54).

Chimpanzee, *Pithecia hirsuta*, and the *Hapale pencillata* both are present, but they are coalesced so as to form a single muscular mass. In the Lemur the two muscles are largely developed, and although they lie side by side are yet easily separated from each other.

The foregoing facts have an important bearing upon the development of these muscles in the human foot. Dr. Ruge[1] has conclusively proved that the transversalis pedis or adductor transversus at an early stage in the development of the human embryo lies in apposition to the adductor obliquus, and that its transverse position in the foot of the adult is due to its travelling forwards towards the heads of the metatarsal bones. The occasional absence of the adductor transversus in Man, together with the fact that, in the young subject, it is always better marked than in the adult (Ruge) would seem to indicate that this muscle is undergoing regressive changes (probably from the confinement of the foot in a boot, and the consequent limitation of the range of movement of the hallux) and that in the course of time it will disappear altogether, or only appear occasionally as an interesting abnormality.

A study of the other members of the plantar layer in the Quadrumana yields results of an equally interesting nature. As a general rule all three (viz., the adductor indicis, adductor annularis, and adductor minimi digiti) are present, so that the plantar group of muscles is represented by its typical number of elements. These are inserted so as to draw the digits towards a line drawn through the medius. The following abstract from Bischoff's memoir upon the *Hylobates leuciscus* will show the arrangement of the adductors :—

Cynocephalus maimon.
Macacus cynomolgus.
Cercopithecus sabaeus.
Pithecia hirsuta.
Ateles.

Plantar layer consists of

1. Adductor hallucis (the two heads of which may be separated or united).
2. Adductor indicis.
3. Adductor annularis.
4. Adductor minimi digiti.

To this list we may add the *Cebus apella* (Ruge) and the Lemur,[2] in both of which the same factors of this group of muscles are found.

Hapale penicillata. Plantar layer consists of

1. Adductor hallucis (the two heads united).
2. Adductor indicis.
3. Adductor minimi digiti.

[1] Processes in the Development of the Muscles of the Human Foot, Morphologisches Jahrbuch, 1878, p. 132.

[2] Murie and Mivart in their memoir upon the Lemuroidea figure and describe only two adductors (in addition to the adductor hallucis), one "going to the peroneal side of the flexor of the index" and the other "going to the tibial side of the fifth digit." In the specimen I dissected there was also an adductor annularis, but it was feebly developed and partially fused with the subjacent muscles. The deep division of the external plantar nerve passed under it, and on detaching the other two adductors from their origin and throwing them forward it also was raised. Its feeble development may be due to abduction taking place, with reference to the annularis. Ruge, on the other hand, in his article upon the deep muscles of the sole of the foot (p. 649), says :—"In the Lemurs, in Loris gracilis, I could find contrahentes for all and even the third toe. The first contrahens (abductor hallucis) consists of two quite distinct heads."

Chimpanzee.[1] *Hylobates leuciscus.*	Plantar layer consists of	1. Adductor hallucis (two heads united in first, but separate in the second). 2. Adductor minimi digiti.
Orang. Gorilla.	Plantar layer consists of	1. Adductor hallucis (two heads united in first, but separated in second).

From this table it will be observed that, whilst in the majority of the animals quoted, the plantar layer is complete, a diminution in the number of its elements can be traced through the *Hapale* and the Chimpanzee and *Hylobates* until we come to the Orang and Gorilla in which there is merely the adductor hallucis. But the Orang seems to stand intermediate between the Gorilla, in which not a vestige of the absent muscles is to be found, and the other apes in which they are present. Ruge has shown in his important article upon the "deep muscles of the foot,"[2] that in this animal the place of the lost adductors of the second, fourth, and fifth toes is taken by tough strands of connective tissue, and that the nature of these is borne out not only by the deep division of the external plantar nerve lying subjacent to them, but also by the presence in connection with them of weakly developed muscular fibres. The regressive changes, therefore, by which these muscles have disappeared are very clearly indicated in the foot of the Orang.

Intermediate layer.—In the Quadrumana we never find a complete layer of flexores breves, *i.e.*, a two-headed muscle provided for each toe. The flexor brevis hallucis and the flexor brevis minimi digiti generally retain their two slips, but the flexor brevis annularis and the flexor brevis indicis are often represented by a single head, whilst the flexor brevis medii seems in the great majority of cases to be absent.

According to Bischoff the Gorilla,[3] the Chimpanzee, the *Hylobates*, the *Cynocephalus*,

[1] Since writing the above I have had the opportunity of examining the foot of a young Chimpanzee. The adductors were three in number, viz.: (1) adductor hallucis, (2) adductor minimi digiti, and (3) adductor annularis. The adductor hallucis was represented by an oblique and a transverse part, both of which were very strongly marked, and in close apposition to each other, but yet quite separable. A very interesting point in connection with the adductor obliquus hallucis was that it was supplied by twigs from both plantar nerves; the internal plantar nerve sent a branch into its superficial surface, whilst the terminal filaments of the deep division of the external plantar nerve sank into its deep surface. Nor could it be said that this double nerve supply was due to its having amalgamated with the outer head of the flexor brevis hallucis, because this muscle was present, although greatly reduced in size from being pressed deeply into the sole by the largely developed adductor. The adductor minimi digiti was well marked, and arose from a central raphe common to it and the transverse adductor of the hallux. The adductor annularis was exceedingly feeble, and took origin from the deep surface of the raphe which separated the adductors of the great and little toes; further, it was partially coalesced with the subjacent interossei, and could not be raised without lacerating muscular fibres.

[2] *Loc. cit.*, p. 650.

[3] Duvernoy and Macalister both describe the flexor brevis hallucis in the Gorilla as consisting of an inner head alone. Bischoff, however, points out that the former has regarded the true outer head as corresponding to the interosseus primus volaris in the hand, whilst the latter has, in all probability, looked upon it as an opponens, a muscle of which Bischoff could find no trace.

the *Cercopithecus*, the *Macacus*, the *Pithecia*, and the *Hapale*, all possess a two-headed flexor brevis hallucis. In many cases, as for example in the Gorilla and *Hylobates*, the outer head is very weakly developed, and as this author expressively terms it "pressed into the deep" by the adductor obliquus. In the Orang it is fused with the oblique adductor, and the double constitution of the muscle thus formed is manifested by its receiving its nerve-supply partly from the internal plantar nerve, and partly from the deep division of the external plantar nerve (Ruge [1]).

But Ruge is of opinion that the outer head of the flexor brevis hallucis must be regarded as a derivative of the inner head of the same muscle. He says: [2]—"In *Ateles* the flexor brevis is a single muscle which is sharply separated from the adductor obliquus by the tendon of the long flexor. It is inserted into the inner sesamoid bone. In *Cercopithecus* the outer flexor is only represented by distal muscular fibres that run from the inner sesamoid bone, under the tendon of the long flexor to the outer sesamoid bone. In *Cebus* these muscular bundles under the long flexor tendon are separate, and now indeed represent a perfectly distinct muscle. It lies between the inner flexor and the oblique head (of the adductor), covered by the tendon of the long flexor."

From these facts, however, we might argue in the opposite direction, and suppose a process by which the outer head, already developed, is gradually reduced in size, and finally absorbed by the inner head. We consider this the more likely interpretation, seeing that a two-headed flexor brevis hallucis is by no means an uncommon occurrence in the lower Mammals.

In the *Cynocephalus sphinx* a very beautiful example is afforded of the manner in which the outer head of the flexor brevis hallucis is reduced in size, and pressed deeply into the interval between the adductor obliquus and inner head of the flexor brevis so as to assume, in fact, a position corresponding to that of a plantar interosseous muscle. In the Lemur there is no trace of the outer head. The oblique adductor [3] is largely developed, but as it draws its nerve supply from the deep division of the external plantar alone, it is not likely that it contains in its midst the lost head of the flexor brevis hallucis.

Flexor brevis minimi digiti.—It is commonly asserted that this muscle in the Ape consists of a single external head. I believe, on the other hand, that it is almost invariably two-headed.[4] The inner head, however, (as is so frequently the case with the outer head of the flexor brevis hallucis) is very often pressed deeply into the sole so that its identity becomes obscured. It is then described under the cognomen of the "third plantar interosseous," muscle.

[1] *Loc. cit.*, p. 651.

[2] *Loc. cit.*, p. 654.

[3] Murie and Mivart describe and figure this muscle under the name of flexor brevis hallucis (*loc. cit.*, p. 86, fig. 30, pl. vi., *f.b.h.*).

[4] In the Chimpanzee which I dissected, the inner head of the flexor brevis minimi digiti (third plantar interosseus) was alone present. The outer head was absent, or rather completely converted into an opponens. In the Chimpanzee which Rolleston examined, this also was the case, but Champneys found an outer head in his specimen.

This inner head is very graphically represented in the drawings of the foot of the *Cynocephalus maimon* which accompany Bischoff's memoir upon the *Hylobates leuciscus* (Pl. IV. fig. 1, *h*, and fig. 2. III.). It can also be seen, although less distinctly, in Ruge's figures of the feet of the *Cebus apella* and Orang (pl. xxxv. figs. 52, 53 and 54). In the *Cynocephalus sphinx* it is very evident, and its association with the outer head of the flexor brevis minimi digiti is marked not only by its lying upon the same plane, but also by both having a common origin from the base of the fifth metatarsal. In the foot of the *Ateles* (?) it has a corresponding origin, but as we trace it towards the metatarso-phalangeal joint it sinks gradually into the fourth inter-metatarsal space, and is inserted into the extensor tendon on the dorsum of the first phalanx of the minimus. In the Lemur it presents precisely the same disposition as in the preceding animal.[1]

With regard to the other members of the intermediate group, a considerable reduction takes place in the number of their elements. In *Cynocephalus sphinx* the flexor brevis indicis is represented by the outer head alone, and the flexor brevis annularis by the inner head alone. These muscles are distinguished from the dorsal interossei not only by their insertions but also by being altogether invisible from the dorsal aspect of the foot. The flexor brevis medii is represented by a single small fleshy slip, which arises from the base of the fourth metatarsal bone and, crossing the third metatarsal obliquely, joins the second dorsal interosseous muscle near its insertion. In Bischoff's drawings of the foot of the *Cynocephalus maimon* (before referred to) the inner head of the flexor brevis annularis, and the outer head of the flexor brevis indicis are figured, but they are named the second and first plantar interossei. The flexor brevis medii is evidently completely gone. In the *Ateles* (?) a similar arrangement is observed, but here indications are to be found which would seem to point to the fact that the lost elements of the intermediate layer have coalesced with certain of the dorsal interossei. On removing the plantar adducting muscles, and also the two heads of the flexor brevis minimi digiti, we are confronted with what appear to be three bicipital muscles lying upon the second, third, and fourth metatarsal bones. These strongly resemble the amalgamated flexores breves and dorsal interossei of the tetradactylous carnivora. A closer examination, however, and an inspection of the dorsal aspect of the foot, will show that the muscles under consideration consist of four bipenniform dorsal interossei, the outer head of the flexor brevis indicis and the inner head of the flexor brevis annularis. The short flexors of the index and annularis are placed not only upon the side, but also upon the plantar aspect of the corresponding metatarsal, and they are united by their margins with the first and fourth dorsal interossei respectively. Further, it is very evident that fibres which appear to rise with those of the short flexors are prolonged upon the thick rounded tendons of the first and

[1] The two heads of the flexor brevis minimi digiti are well seen in fig. 30, pl. vi., illustrating Murie and Mivart's Memoir upon the Lemuroidea.

fourth dorsal interossei to be inserted into the outer sesamoid bone of the annularis in the one case and the inner sesamoid bone of the index in the other case. I believe that these fibres, thus incorporated with those dorsal interosseous muscles, represent the lost outer head of the flexor brevis indicis, and the lost inner head of the flexor brevis annularis. Then, with regard to the medius, we notice a thin stratum of muscular fibres, covering the plantar aspect of the middle metatarsal bone, and uniting the plantar margins of the second and third dorsal interossei. This bifurcates lower down, and the two fleshy slips thus formed run along the tendons of these dorsal interossei to be inserted into the sesamoids of the medius. I am inclined to believe that these slips, although incorporated with the dorsal interossei, represent the flexor brevis medii.

In the Lemur the flexor brevis annularis is apparently absent; the flexor brevis medii has two heads; but its inner head, almost immediately after its origin, joins the second dorsal interosseous muscle, and cannot be regarded as having an independent insertion; the outer head of the flexor brevis indicis is alone present. Murie and Mivart, in their memoir upon the Anatomy of the Lemuroidea, include these muscles under the heading of interossei. They say :—"In *Lemur catta* there are two to each digit, except the hallux, and counting the flexor brevis minimi digiti as one." They are, however, easily distinguished from the dorsal interossei from the latter being feebly bipenniform and also from the fact that the flexores breves can only be seen from the plantar aspect of the foot.

Dorsal layer.—This layer is generally represented by its complement of muscles. The abductor minimi digiti is usually more strongly developed than the corresponding muscle of the hallux, and as a rule it springs from the tuber of the os calcis. An abductor ossis metatarsi minimi digiti is also frequently present although not always separable from the preceding muscle. In the *Cynocephalus sphinx* it is very feebly represented; in the *Ateles* (?) it is absent, and in the Lemur it is strongly marked. In the Chimpanzee the abductor ossis metatarsi is absent.

The abductor hallucis, whilst it takes origin, in many cases, from the os calcis, is often very poorly developed. In *Cynocephalus sphinx* it is a very small slip which springs from the internal cuneiform bone; in *Ateles* (?) it arises from the scaphoid, and in the Lemur from the plantar fascia.

The dorsal interossei may be one-headed muscles, as in *Cynocephalus sphinx*, and arise from the bases of the metatarsal bones, or they may be bipenniform, as in the Chimpanzee, *Ateles* (?), Lemur, &c., and spring from the shafts of the metatarsals between which they lie. The first member of the series, owing to the first and second metatarsals being so far apart, is usually two-headed.

In all the Quadrumana, with two exceptions, the dorsal interossei are inserted so as abduct the toes from a line drawn through the medius, as is the case in the human hand: thus the first is inserted upon the inner side of the base of the first phalanx of the index;

the second and third are inserted one upon either side of the base of the first phalanx of the medius; and the fourth is inserted upon the outer side of the base of the first phalanx of the annularis. The two exceptions to this rule are—(1) the Gorilla, and (2) the Lemur.

Bischoff[1] has recently shown that in the Gorilla the pedal dorsal interossei are arranged in the same manner as in the human foot, viz., with reference to a line drawn through the index or second toe. Duvernoy[2] and Macalister,[3] however, differ from Bischoff upon this point, and consider the foot of the Gorilla no exception to the general rule, and therefore it is possible that the disposition of these muscles in this animal may vary.

In the Lemur I find that the dorsal interossei are arranged with reference to a line drawn through the annularis. The first is inserted upon the inner side of the base of the index; the second upon the same side of the base of the medius; and the third and fourth upon either side of the base of the annularis. This is very evident when these muscles are dissected from the dorsal aspect of the foot.[4] In the manus the dorsal interossei are arranged upon the same plan. Duvernoy considers the peculiarity of arrangement in the human foot to be due to the fact that the index which constitutes the centre for the movements of abduction and adduction is the longest of the toes. It is interesting to note in connection with this that the annularis is the longest digit in the foot of the Lemur. In the Gorilla, on the other hand, the medius is the longest toe.

Bimana.

We must now endeavour to determine the relation which exists between the intrinsic muscles of the human foot, and those of the feet of the lower animals. There is no difficulty in recognising the members of the dorsal layer. They are—

1. The abductor hallucis.
2. The abductor minimi digiti.
3. The occasional abductor ossis metatarsi minimi digiti.
4. The four dorsal interossei.

The plantar layer is represented by (1) the adductor hallucis, and (2) the transver-

[1] Beiträge zur Anatomie des Gorilla—Aus den Abhandlungen der K. bayer Akademie der W. II., clxiii. Bd. iii. Abth.

[2] *Loc. cit.* [3] *Loc. cit.*

[4] This is very clearly and beautifully represented in plate lxxv. (figs. 1 and 2) of the Atlas (vol. ix.), which accompanies the text (vol. vi.) of the great work which has recently appeared entitled "Histoire Physique, Naturelle et Politique de Madagascar," by M.M. Alph. Milne-Edwards and Alfred Grandidier. In the text of vol. vi. which is devoted to the Lemurs, reference is made in page 191 to this disposition of the dorsal interossei, but the authors hardly seem to have realised its full importance. They say :—"Dans l'intervalle qui sépare le troisième métatarsien du quatrième, et celui-ci du cinquième orteil existent deux interosseux dorsaux qui se fixent de chaque côté de la premiere phalange du quatrieme orteil." In the case of the manus it is neither figured nor described.

salis pedis, whilst the flexor brevis hallucis and the flexor brevis minimi digiti belong to the intermediate layer.

So far there can be no dubiety; but to which layer are we to relegate the three plantar interosseous muscles? In two short abstracts of portions of this Report which I published in the Journal of Anatomy and Physiology,[1] I placed these three muscles in the plantar layer, and therefore, classed them with the adductor obliquus and adductor transversus hallucis. In doing so I followed in a great measure the views of Meckel.[2] Such views, however, I now consider to be erroneous, and I believe that the plantar interrossei in reality belong to the intermediate or flexor group of muscles. This opinion is based upon the following facts:—

(1) In the quadrumana we have traced the gradual disappearance of all the adductor muscles except those belonging to the great toe.

(2) We find plantar interossei not only in those apes which have a complete adducting apparatus (*e.g. Cynocephalus*), but also in those in which it is only represented by the adductors of the hallux and fibrous bands (*e.g.* Orang), and in those in which it is reduced, to the adductors of the great toe alone (*e.g.* Gorilla).

(3) Ruge[3] has pointed out that the deep division of the external plantar nerve, as it runs inwards across the sole, is placed between the adducting muscles and the other

[1] Intrinsic Muscles of the Manus of *Thylacine*, *Cuscus*, and *Phascogale*, Jour. Anat. and Phys., vol. xiii. p. 443. Intrinsic Muscles of the Mammalian Foot, Jour. Anat. and Phys., vol. xiii. p. 12.

[2] The views held by J. F. Meckel regarding the homologies of the intrinsic muscles of the human hand and foot may be gathered from the following quotations from his work entitled "Descriptive and Pathological Anatomy," translated from the French by A. S. Doane, M.D., and published in 1839. In Vol. I. p. 283, he says:—"The proper muscles of the thumb and little finger are only the lumbricales or interossei muscles largely developed and divided into several fasciculi. We must consider the flexor pollicis brevis muscle as the first lumbricalis. The abductor pollicis brevis and the opponens pollicis correspond to an external (*i.e.* dorsal); the adductor represents an internal (*i.e.* palmar) interosseous muscle. The abductor and flexor brevis minimi digiti muscles form only one muscle, which represents the last external interosseous muscle. The adductor minimi digiti (opponens) muscle is only an enlarged internal interosseous muscle." Then in page 318 he advances the following opinions regarding the intrinsic muscles of the foot: "The muscles of the large and the small toes may be referred to the other muscles of the foot, as we have seen those of the thumb and little finger could be to the other muscles of the hand. The abductor pollicis pedis is the first external interosseous muscle, and the posterior belly of the abductor? (adductor obliquus) the first internal interosseous muscle. The anterior belly of the latter (adductor transversus) represents the first lumbricalis. . . . The abductor minimi digiti is the last external interosseous muscle. Finally, the flexor brevis minimi digiti may be considered as belonging to the flexor digitorum communis, because of the slight development of the fourth tendon of the latter in most subjects." The words in brackets have been introduced by myself.

The close association of the flexor brevis pollicis and the flexor brevis minimi digiti with the long flexor tendons has evidently suggested to this author the view that these muscles in the hand are simply exaggerated and highly developed lumbrical muscles. It is not borne out, however, by an examination of the same muscles in the hand and foot of lower animals; indeed a totally different view of the case is suggested. We have seen that the short flexors of the marginal digits in many animals lie in series with three other muscles, which have precisely the same relation to the index, medius and annularis as they have to the first and fifth digits. It is reasonable, therefore, to conclude that they all belong to one group. But an additional argument is afforded against Meckel's theory by Dr. Young of Manchester, in his paper upon the "Intrinsic Muscles of the Marsupial Hand" (*loc. cit.*). In his dissection of the hand of the yellow-footed Rock Kangaroo he noticed that the pollex was furnished with a lumbrical muscle in addition to its two-headed flexor brevis.

[3] "Upon the Comparative Anatomy of the Deep Muscles in the Sole of the Foot (*loc. cit.*, p. 645).

members of the intrinsic group. This is a most useful, and, as a general rule, a most reliable guide in determining the muscles which belong to the plantar layer. He says the deep division "sinks at the outer edge of the contrahentes (*i.e.*, adductors) between these and the interossei. This nerve courses inwards, constantly placed on the interossei and covered by the contrahentes and giving branches to both groups." Now in Man this nerve passes inwards superficial to the plantar interossei and under cover of the adductor obliquus hallucis, thus cutting them off from each other.

(4.) In a foot dissected in the Practical Anatomy Rooms of the University of Edinburgh this summer session (1881), I observed a distinct fleshy slip proceeding from the outer edge of the adductor obliquus hallucis to be inserted into the outer side of the base of the first phalanx of the index. This clearly represented the adductor indicis.

The flexor brevis minimi digiti is a single-headed muscle which is inserted into "the base and external border of the first phalanx of the little toe" (Quain). I believe that the third plantar interosseus is the inner head of this muscle.

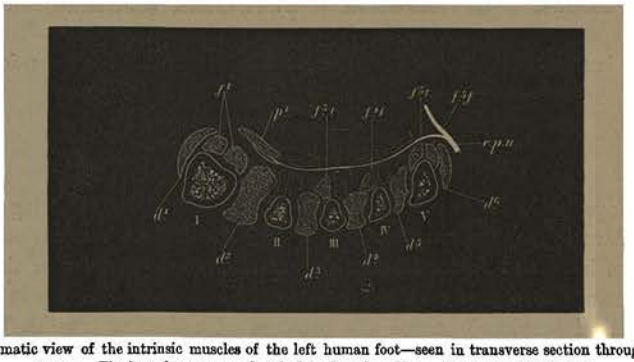


FIG. 2. Schematic view of the intrinsic muscles of the left human foot—seen in transverse section through the metatarsus. The lost elements are sketched in dotted outline. Compare with figure 3.

(f^1) Flexor brevis hallucis. (f^3 *t*) Tibial head of flexor brevis medii (1st plantar interosseus). (f^4 *t*) Tibial head of flexor brevis annularis (2nd plantar interosseus). (f^5 *t*) Tibial head of flexor brevis minimi digiti (3rd plantar interosseus). ($f^5 f$) Fibular head of flexor brevis minimi digiti. (p^1) Adductor obliquus hallucis. (d^1) Abductor hallucis. (d^5) Abductor minimi digiti. (d^2 to d^5) Dorsal interossei. (I. to V.) Metatarsal bones. (*e.p.n*) External plantar nerve giving off its superficial and deep division.

The remaining two plantar interossei (viz., the second and first) are the flexores breves of the annularis and medius, which have lost their outer heads, and have taken on an adducting action in consequence, antagonising in this respect the action of the fourth and third dorsal interossei.

Nor need we consider this change of function remarkable when we have already seen in the Horse a short flexor converted into a powerful ligament; in the Sloth

the flexores breves wandering to the dorsum of the foot and acting as extensors; and in some marsupial and monotrematous animals a new and opposite action added to the abductors, viz., that of approximation.

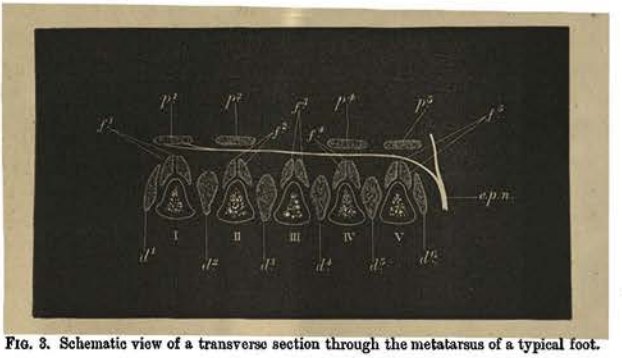


FIG. 3. Schematic view of a transverse section through the metatarsus of a typical foot.

(p^1 to p^5) Adductores. (f^1 to f^5) Flexores breves. (d^1 to d^6) Abductores. (*e.p.n.*) External plantar nerve.

The flexor brevis indicis is completely lost in the human foot—not a trace of it is to be found.

General Remarks.

Plantar layer.—To Bischoff and Halford is due the credit of being the first to describe an adducting muscular apparatus homologically distinct from the other intrinsic muscles of the hand and foot. Bischoff's observations were confined to the Apes, and he did not include as a part of this apparatus the adductor hallucis. It is true that many writers had previously noted the presence of adducting muscles, but all had failed to recognise their true import. Professor Halford not only gives an account of the muscles composing this layer in the foot of the Macacus, but he applies to them the distinctive name of "contrahentes digitorum"—a name which Bischoff adopts. In the abstract of this portion of my report which I published in the Journal of Anatomy and Physiology in 1878, I described these muscles in a large number of the lower mammals, and placed the adductor hallucis amongst them. To the group thus constituted I gave the name of "plantar layer of adductors." In this paper, however, I fell into the error of considering the plantar interossei of the human foot as members of the layer. A few months later, Ruge's article upon the Deep Muscles of the Sole of the Foot appeared, in which he also recognised the true position of the adductor hallucis by placing it amongst the contrahentes or adductors. Further, he pointed out, by means of the deep division of the external plantar nerve, that the adductores digitorum

were distinct from the plantar interossei. He offered no suggestions regarding the homologies of the latter beyond stating that they were "interossei." In his former paper upon the Development of the Muscles of the Human Foot, he includes the flexor brevis minimi digiti with the musculi interossei pedis.

Subjoined is a tabular view of the distribution of the adducting muscles in Mammals.

The asterisk (*) is placed at the point towards which the adducting muscles operate. Where the + is used, the muscle in the corresponding column is absent.

PLANTAR LAYER—ADDUCTORES. (TABLE A.)

Pentadactylous Feet.

	Adductor hallucis.	Adductor indicis.	Adductor medii.	Adductor annularis.	Adductor minimi digiti.
Echidna setosa,	Present *	Present	Present	Present	Present
Phascolarctos cinereus,	,,	,,	,,	,, +	,,
Ornithorhynchus paradoxus,	,,	+	,,	,,	,,
Dasyurus viverrinus,	,,	Present	+	,,	,,
Phascogale calura,	,,	,,	+	,,	,,
Didelphys virginiana,	,,	,,	+	,,	,,
Dasypus sexcinctus,	,,	,,	+	,,	,,
Cynocephalus maimon (Bischoff),	,,	,,	+	,,	,,
Macacus cynomolgus (Bischoff),	,,	,,	+	,,	,,
Cercopithecus sabaeus (Bischoff),	,,	,,	+	,,	,,
Pithecia hirsuta (Bischoff),	,,	,,	+	,,	,,
Ateles,	,,	,,	+	,,	,,
Cebus apella (Ruge),	,,	,,	+	,,	,,
Lemur,	,,	,,	+	,,	,,
Cuscus maculata,	,,	+	...	,,	,,
Phalangista vulpina; Specimen A,	,,	+	...	,,	,,
Phalangista vulpina; Specimen B,	,,	Present	...	+	,,
Myrmecophaga tamandua,	,,	,,	...	+	,,
Meles taxus,	,,	,,	+	...	,,
Lutra vulgaris,	,,	,,	+	...	,,
Mustela putorius,	,,	,,	+	...	,,
Cœlogenys paca,	,,	,,	+	...	,,
Hapale penicillata (Bischoff),	,,	,,	+	...	,,
Pteropus,	,,	...	+	...	,,
Chimpanzee (Bischoff),	,,	...	+	...	,,
Hylobates leuciscus (Bischoff),	,,	...	+	...	,,
Trichechus rosmarus,	,,	...	...	...	...
Castor fiber,	,,	...	...	...	...
Orang (Bischoff),	,,	...	+	...	...
Gorilla (Bischoff),	,,	...	...	...	...
Homo,	,,	...	...	...	...
Elephas indicus,	...	Present	...	...	...
Bathyergus capensis,	...	...	...	...	...
Mus capensis,	...	...	...	...	...
34	31	21	3	16	26

Plantar Layer—Adductores. (Table A)—*continued.*

Tetradactylous Feet.

(*Hallux* absent, or very rudimentary.)

	Adductor indicis.	Adductor medii.	Adductor annularis.	Adductor minimi digiti.
Thylacinus harrisii,	Present	+	Present	Present
Canis familiaris,	,,	+	,, (?)	,,
Dingo (Australian Wild Dog),	,,	+	...	,,
Felis catus,	,,	+	...	,,
Felis concolor,	,,	+	...	,,
Felis leopardus,	,,	+	...	,,
Felis leo,	,,	+	...	,,
Sus scrofa,	,,	+	...	,,
Lepus timidus,	,,	+	...	,,
Macropus robustus,	...	...	...	,,
10	9	...	2	10

Tridactylous Feet.

	Adductor indicis.	Adductor medii.	Adductor annularis.
Hyrax capensis,	Present	+	Present
Bradypus tridactylus,	...	...	...

This table brings out that the plantar layer constitutes a very constant part of the intrinsic muscle apparatus of the mammalian foot. In the feet of forty-six different species possessed of three or more toes it is absent entirely in three cases only. In the monodactylous and didactylous feet of Solipeds and Ruminants not a trace of adducting muscles is to be found. But, further, the table shows the relative constancy of the different members of the group. The starting-point is the *Echidna*, in which there are five muscles, one for each toe. Ruge[1] considers the original number to be six, and he describes that number in the *Ornithorhynchus*, viz., two for the minimus, and one for each of the other digits. One of the two which he refers to the minimus we have already seen to be in reality the outermost belly of the flexor brevis digitorum, and not an intrinsic muscle at all. Although I was unable to find an adductor indicis in the four specimens of this animal I examined, I would consider that its occasional presence is a very likely occurrence seeing that it is constantly present in the Echidna. A glance at the table will show that

[1] Upon the Comparative Anatomy of the Deep Muscles of the Sole of the Foot.

whilst five is the original number, there is a distinct tendency exhibited for the adductors to disappear from the centre of the foot towards the margins, and this disappearance takes place in a more marked degree in an outward direction towards the minimus than in an inward direction towards the hallux. Thus the adductor hallucis and the adductor minimi digiti are the most constant—the former or more internal of the two much more so than the latter or more external. The adductor indicis and adductor annularis rank next in point of constancy, but the adductor indicis, which is the more internal of the two, is more frequently present than the adductor annularis. The central adductor, viz., the adductor medii, was only found in three specimens. The sudden disappearance of this adductor is probably due to the tendency which these muscles have to arrange themselves so as to act with reference to the middle toe. The exact ratio of constancy of the different members of this group of intrinsic muscles can be seen by a reference to the table.

Intermediate and dorsal layers.—At the end of Ruge's paper upon the Deep Muscles in the Sole of the Foot[1] there is the following statement:—"During the printing of this work I notice that D. J. Cunningham divides the deep muscles of the mammalian foot into three divisions—(*a*) plantar (adductores), (*b*) intermediate (flexores breves), (*c*) dorsal (abductores). I hold it incorrect to extend this subdivision to all mammals, especially since, even according to Cunningham, a fusion of layers *b* and *c* is very common."

I fail to perceive wherein Dr. Ruge should consider this classification of the intrinsic muscles "incorrect," seeing that throughout his two papers he indirectly admits it. Thus he makes the great primary division into (1) contrahentes, and (2) interossei, and then he divides the latter[1] into (*a*) a palmar, and (*b*) a dorsal series. Is this not a clear subdivision into three layers, or in other words, a trilaminar arrangement? The muscles of the minimus and the muscles of the hallux he describes as two separate groups. Why he should consider the muscles of the marginal digits distinct from those of the other toes I cannot understand. I have found no grounds upon which we can base a difference, beyond the fact that from the more commanding position of these toes it frequently happens (more especially in the case of the minimus) that their muscles have undergone greater development, and it may be segmentation.

Dr. Young of Manchester in answer to Ruge's criticism remarks:—"It is difficult to understand why the fusion of two previously existing layers, however common, should in any way militate against the view that the separate condition was more typical than the coalesced; conversely, indeed, if the fact of their fusion be in all cases established, it certainly seems to favour Dr. Cunningham's views of the type arrangement." I cannot take advantage of this argument, forcible though it be, because I do not consider that we

[1] *Loc. cit.*, p. 657.

[2] In his Memoir upon the development of the foot (*loc. cit.*) he says, "In the group of interossei pedis which at present with general acceptance is divided into the four outer or dorsal, and the three plantar or inner, I include the flexor brevis minimi digiti, &c. &c."

have in every case clear proof that muscles when absent are lost by fusion (as for example the Hare, the Fox-Bat, the *Bathyergus*, the Cape-Mouse, &c. &c.).

If we study the subjoined tabular views of the intrinsic pedal muscles in mammalia, a considerable amount of light is thrown upon the relations of the different layers to each other. We notice—(1) that the intermediate group is the most constant of the three layers; (2) that the dorsal layer is the least constant, and the most variable, in several cases being wholly unrepresented; (3) that there is a striking tendency to fusion between the members of the intermediate and dorsal groups of muscles; and (4) that the plantar muscles almost invariably remain distinct from the subjacent muscles.

INTERMEDIATE LAYER—FLEXORES BREVES. (TABLE B.)

Pentadactylous Feet.

	Flexor brevis hallucis.	Flexor brevis indicis.	Flexor brevis medii.	Flexor brevis annularis.	Flexor brevis minimi digiti.
Cuscus maculata,	Both heads	Both heads	Both heads	Both heads	Both heads
Didelphys virginiana,	,,	,,	,,	,,	,,
Bathyergus capensis,	,,	,,	,,	,,	,,
Mus capensis,	,,	,,	,,	,,	,,
Pteropus,	,,	,,	,,	,,	,,
Trechechus rosmarus,	Fibular head tibial head (?)	,,	,,	,,	,,
Phascogale calura,	Tibial head	,,	,,	,,	,,
Lutra vulgaris,	,,	,,	,,	,,	,,
Phalangista vulpina,	Both heads	,,	,,	,,	Fibular head
Phascolarctos cinereus,	,,	,,	,,	,,	Tibial head
Dasyurus viverrinus,	Tibial head (fused with abductor)	,,	,,	,,	Both heads
Ornithorhynchus paradoxus,	Tibial head	,,	,,	,,	...
Meles taxus,	Both heads	,,	Tibial head	Tibial head	Both heads
Elephas indicus,	...	,,	Both heads	Both heads	Tibial head
Cœlogenys paca,	Tibial head	,,	,,	,,	Fibular head
Castor fiber,	...	,,	,,	,,	...
Myrmecophaga tamandua,	Tibial head	Tibial head	Tibial head	Tibial head	Both heads
Ateles,	Both heads	Fibular head	...	,,	,,
Cynocephalus sphinx,	,,	,,	Tibial head	,,	,,
Lemur,	Tibial head	,,	Both heads	...	,,
Homo,	Both heads	...	Tibial head	Tibial head	,,
Echidna setosa,	,,	Tibial head	...	...	Fibular head
Armadillo,	,,	...	...	...	,,
	Both heads, 13 Tibial head, 7 Fibular head, 1	Both heads, 16 Tibial head, 2 Fibular head, 3	Both heads 16 Tibial head, 4 Fibular head, ...	Both heads, 15 Tibial head, 5 Fibular head, ...	Both heads, 15 Tibial head, 2 Fibular head, 4
Total, 23	Total, 21	Total, 21	Total, 20	Total, 20	Total, 21

Intermediate Layer—Flexores Breves. (Table B)—*continued.*

Tetradactylous Feet.

(*Hallux* suppressed, or very rudimentary.)

	Flexor brevis indicis.	Flexor brevis medii.	Flexor brevis annularis.	Flexor brevis minimi digiti.
Thylacinus harrisii,	Both heads	Both heads	Both heads	Both heads
Lepus timidus,	,,	,,	,,	,,
Canis familiaris,	Both heads (fused with dorsal interossei)	Both heads (fused with dorsal interossei)	Both heads (fused with dorsal interossei)	Both heads (fibular head fused with abductor minimi digiti)
Dingo (Australian Wild Dog),	,,	,,	,,	,,
Felis catus,	,,	,,	,,	,,
Felis concolor,	,,	,,	,,	,,
Felis leopardus,	,,	,,	,,	,,
Felis leo,	,,	,,	,,	,,
Sus scrofa,	Tibial head	Tibial head	Fibular head	Fibular head
Macropus robustus	,,	,,	Both heads	Both heads
	Both heads, . . 8 Tibial head, . . 2	Both heads, . . 8 Tibial head, . . 2	Both heads, . . 9 Fibular head, . 1	Both heads, . . 9 Fibular head, . 1
Total, 10	Total, 10	Total, 10	Total, 10	Total, 10

Tridactylous feet.

	Flexor brevis indicis.	Flexor brevis medii.	Flexor brevis annularis.
Hyrax capensis,	Both heads	Both heads	Both heads
Bradypus tridactylus,	...	...	...

Dorsal Layer—Abductores. (Table C.)

Pentadactylous Feet.

	Abductor hallucis	First dorsal interosseus.	Second dorsal interosseus.	Third dorsal interosseus.	Fourth dorsal interosseus.	Abductor minimi digiti.
Phascogale calura,	Present	Present	Present	Present	Present	Present. 2 parts—for metatarsal and for phalanx.
Didelphys virginiana,	,,	,,	,,	,,	,,	Present. 3 parts—for metatarsal, for sesamoid, and for extensor tendon.
Myrmecophaga tamandua,	,,	,,	,,	,,	,,	Present. 2 parts—for metatarsal and for phalanx.
Lutra vulgaris,	,,	,,	,,	,,	,,	Present. 1 part only, viz., abductor metatarsi.

Dorsal Layer—Abductores. (Table C)—*continued.*

Pentadactylous Feet—continued.

	Abductor hallucis.	First dorsal interosseus.	Second dorsal interosseus.	Third dorsal interosseus.	Fourth dorsal interosseus.	Abductor minimi digiti.
Dasyurus viverrinus,	...	Present	Present	Present	Present	Present. 3 parts: (1) for metatarsal, (2) for sesamoid, (3) for extensor tendon.
Ornithorhynchus paradoxus,	..	,,	Present (approximator)	Present (approximator)	,,	Present. 1 part only, viz., abductor metatarsi.
Meles taxus,	...	,,	Present	Present	,,	Present. 1 part only, viz., abductor metatarsi.
Castor fiber,	Present	,,	...	,,	...	Present.
Cœlogenys paca,	,,	,,	...	...	Present	Present. 1 part only, viz., abductor metatarsi.
Cuscus maculata,	,,	,,	...	Present (approximator)	,, (approximator)	Present. 3 parts: (1) for metatarsal, (2) for sesamoid, (3) for extensor tendon.
Phalangista vulpina,	,,	,,	...	Present (approximator)	Present (approximator)	Present. 2 parts: (1) for metatarsal. (2) for phalanx.
Homo,	,,	,,	,,	Present	Present	Present.
Cynocephalus sphinx,	,,	,,	,,	,,	,,	Present. 2 parts: (1) for metatarsal, (2) for phalanx.
Ateles,	,,	,,	,,	,,	,,	Present.
Lemur,	,,	,,	,,	,,	,,	Present. 2 parts: (1) for metatarsal. (2) for phalanx.
Phascolarctos cinereus,	,,	,,	...	...	...	Present. 2 parts: (1) for metatarsal, (2) for phalanx.
Echidna setosa,	,,	...	Present (approximator)	...	...	...
Dasypus sexcinctus,	,,	...	...	...	...	Present. 2 parts: (1) for metatarsal, (2) for phalanx.
Trechechus rosmarus,	,,	...	...	Present	...	Present. 3 parts: (1) for metatarsal, (2) for sesamoid (?) (3) for extensor tendon (?).
Elephas indicus,	...	...	...	...	...	Present.
Bathyergus capensis,	...	...	...	...	...	...
Mus capensis,	...	...	...	...	...	...
Pteropus,	...	...	...	...	...	...
23	16	16	12	15	14	(1) Total number of times present in one or other form. 19
			2 Approximators	3 Approximators	2 Approximators	(2) Abductor ossis metatarsi. 15
			10 Abductors	12 Abductors	12 Abductors	(3) Single abductor minimi digiti. 11
						(4) Double abductor minimi digiti. 4

Dorsal Layer—Abductores. (Table C.)—*continued.*

Tetradactylous Feet.

	First dorsal interosseus.	Second dorsal interosseus.	Third dorsal interosseus.	Fourth dorsal interosseus.	Adductor minimi digiti.
Thylacinus harrisii, . .	Present	Present	Present	Present	Present. 3 parts: (1) for metatarsal, (2) for sesamoid, (3) for extensor tendon.
Canis familiaris, . .	Present, but fused with the flexor brevis.	Present, but fused with the flexor brevis.	Present, but fused with the flexor brevis.	Present, but fused with the flexor brevis.	
Dingo (Australian Wild Dog), . . .	,,	,,	,,	,,	...
Felis concolor, . . .	,,	,,	,,	,,	Present. 2 parts: (1) for metatarsal, (2) for extensor tendon.
Felis leopardus, . . .	,,	,,	,,	,,	Present. 3 parts: one of which is the abductor metatarsi.
Felis leo, ...	,,	,,	,,	,,	Present. 2 parts: (1) for metatarsal, (2) for extensor tendon.
Lepus timidus, . . .	...	...	...	...	...
Sus scrofa, . . .	...	...	...	...	...
Macropus robustus, . .	...	...	...	...	...
9	6	6	6	6	(1) Total number of times present in one form or other. 4 (2) Abductor ossis metatarsi. 4 (3) Single abductor minimi digiti. 2 (4) Double abductor minimi digiti. 2

Tridactylous Feet.

	First dorsal interosseus.	Second dorsal interosseus.	Third dorsal interosseus.	Fourth dorsal interosseus.
Hyrax capensis, ...	Present	Present	...	...
Bradypus tridactylus, ...	,,	,,	Present	Present
2	2	2	1	1

All this points to an exceedingly close association between the intermediate and dorsal layers, and possibly also to the fact that the latter (*i.e.*, the dorsal interossei, the abductor hallucis, and the abductor of the minimus) may have originally been derived from the former (*i.e.*, the flexores breves). Ruge's researches into the development of the muscles of the human foot decidedly favour this view. He has shown that at a very early stage the muscles are plantar, and that it is only as development advances that the dorsal interossei pass upwards between the metatarsal bones.

It is interesting to note that whereas the adductor of the hallux is the most constant and frequently the most highly developed muscle of the plantar layer, it is the abductor minimi digiti which is the most constant and most highly differentiated member of the dorsal layer.

It is convenient to notice at this stage the criticism which Dr. Young has made upon the abstract of this portion of my report, which I published in 1878. He examined the hands of five Marsupials, viz., the Opossum, Wallaby, yellow-footed Kangaroo, Wombat, and Koala. From these dissections he concludes that, "with respect to the disposition of the intrinsic muscles of the hand and foot, a considerable number of Marsupials agree closely with what has been laid down as the actual type, upon which these muscles are arranged in the whole of the mammalia. But it does not appear that this 'type' is so constantly adhered to in any other group of the Mammalia; on the contrary, the deviations from it are so numerous and of such a nature as to render the justifiability of its extension to all mammals questionable." It is true that it is in "the Marsupials as a class that we find the typical arrangement most closely adhered to," but we have simply to glance over the foregoing tables to see that the mammals are very few indeed in which we do not find indications of all the three layers. Putting aside the plantar muscles as a layer about which there can be no dispute, it will be observed, that in every animal, with one exception (viz., the *Bradypus*), there is a distinct flexing group, and that in almost every case one muscle from this layer is allotted to each toe. The dorsal layer, although it is the most fully represented of the three groups in Man, is the one which in the lower animals is least constant and most variable. In very few instances, however, do we find it wholly unrepresented. Surely Dr. Young is not prepared to abolish this layer. If any is to be abolished it must be the dorsal layer.

But another paragraph in Dr. Young's article leads me to believe that he applies a wider meaning to the word typical than I have any intention to convey. He says:—"The history of the developmental changes, indeed, will afford the only sure data for the determination of that fundamental arrangement which alone can be considered as constituting an actual and inclusive type in contradistinction to one purely ideal or hypothetical." I have no wish to claim that the trilaminar arrangement is the fundamental or original disposition of the intrinsic pedal muscles in Mammalia. On the contrary I am strongly of opinion that it is not so, and I have already hinted that they are strong arguments in

favour of looking upon the dorsal muscles, as derived secondarily from the flexors. Fixity of structure is an impossibility. There are few cases, indeed, in which, either by comparative or developmental research, anatomists are able to penetrate so far into the obscurity which surrounds the history of the changes which structure undergoes as to found an absolute fundamental type. It is very questionable whether such is possible in any case. The three chief movements of a digit are adduction, flexion and abduction. When each digit is supplied with an independent intrinsic muscle for the production of each of these movements the three sets of muscles assume the trilaminar arrangement. Such a hand or foot is typical in so far as it presents an arrangement to which all other hands or feet can be referred.

The centre for the movements of adduction and abduction.—A decided tendency is exhibited throughout Mammalia generally for the adductors and abductors of the toes to arrange themselves with reference to the medius or middle digit. It thus comes about that the adductor medii disappears and two dorsal interossei or abductors are allotted to the medius, one for each side. There are a great number of exceptions to this rule. In *Echidna* adduction takes place towards the interval between the hallux and index; in the *Ornithorhynchus*, *Cuscus*, and *Phalangista vulpina* (?) towards the index; in the Koala, *Phalangista vulpina* (?), and Tamandua towards the annular digit. In other cases, where only one or perhaps two adductors are present, it is impossible to make out the exact point, although it may be presumed to be the central line of the foot. Exceptions in the case of the abductors are of rarer occurence. We may quote, however, Man, the Gorilla, and the Tamandua as marked instances in which the centre of abduction is the index, and the Lemur, as an instance in which the annular digit constitutes the centre. It sometimes happens that the centre of adduction does not correspond with that of abduction. The Tamandua and the Lemur are examples of this. In the former there is no adductor of the medius; but the line of origin of the three remaining adductors is over the metatarsal of the annularis, and therefore we conclude that they operate towards this digit, and that the adductor indicis in acting upon the index has an indirect influence upon the medius as well. The abductors are, on the other hand, distinctly arranged with reference to the index—two being appropriated to this digit, and the others being inserted into the outer sides of the medius, annularis, and minimus, and into the inner side of the hallux respectively. In the Lemur, whilst abduction takes place with reference to the annularis, adduction is effected with reference to the medius. The adductor annularis, however, which is rendered useless by the fact that this digit is supplied by two dorsal interossei is evidently fast disappearing, indeed it is not described by Murie and Mivart.

In the foot of Man, the Gorilla, &c., certain of the flexores breves by the loss of one of their heads became adductors, and thus placed themselves in antagonism to the abductors. In tables A. and C. the centres of adduction and abduction are indicated as far as it is possible to do so by the introduction of an asterisk (*).

Adaptation of the intrinsic muscle-apparatus to the requirements of the pes.—It is a question about which there can be no dispute that the number and arrangement of the intrinsic pedal muscles are in a great measure dependent upon the special functions required of the foot. It is disappointing, however, to find so little clear proof of this in the mammalian pes.

Let us take three well-marked examples of burrowing animals from different orders, viz., the *Echidna*, the *Bathyergus*, and the Badger, and compare the disposition of the intrinsic muscles of their feet. The result is found to be highly unsatisfactory. In the *Echidna* the only layer well represented is the plantar layer. Each digit is supplied with an adductor. Flexores breves on the other hand are only found in connection with the small hallux, the index and the minimus and abductores in connection with the hallux and index. In the *Bathyergus* the flexores breves are alone developed—one being furnished to each toe. Not a trace of adductores or of abductores exists. In the Badger all three layers are well represented; thus there are three adductors, five flexores breves, and five abductors.

If we next contrast the feet of four aquatic animals, viz., the Otter, the Beaver, the *Ornithorhynchus*, and the Walrus we obtain equally unsatisfactory results. In the Otter the intrinsic pedal muscles meet almost all the requirements of the typical trilaminar arrangement. Each digit is supplied with three muscles, with the exception of the annularis which wants an adductor. In the *Ornithorhynchus* the digits are also well furnished with intrinsic muscles, but these are arranged upon a different plan, and there is great difficulty experienced in separating the flexores breves from the dorsal interossei. The abductor hallucis, and the flexor brevis minimi digiti are absent; and further, the second and fourth dorsal interossei are developed into approximators. In the Beaver and Walrus, on the other hand, the plantar layer is only represented by a feeble adductor hallucis. With regard to the intermediate layer, the Walrus possesses a distinct flexor brevis for each toe, whereas in the Beaver the flexores breves are restricted to the index, medius, and annularis. The disparity in the dorsal layer is even more marked. In the Walrus there is a powerful abducting apparatus connected with the minimus, a very rudimentary abductor hallucis, and one questionable dorsal interosseus present, viz., the third. In the Beaver, the abducting apparatus of the minimus is feeble in the extreme; the abductor hallucis is well developed, and there are two well-marked dorsal interossei, viz., the first and the second.

In the dissection of these aquatic feet I was struck with the uniform feeble development of the abducting apparatus of the marginal digits. I fully expected that these muscles would be largely developed for the purpose of expanding the web. In the Walrus alone is the abductor minimi digiti well marked. In the Beaver it is very feeble, and in the *Ornithorhynchus* and Otter it is only represented by the metatarsal portion, viz., the abductor ossis metatarsi minimi digiti. Then with regard to the abductor hallucis: in the *Ornithorhynchus* it is absent, in the Walrus and Otter it is very feeble, and in the

Beaver alone is it a tolerably well developed muscle. On reflection, the reason of this weakness of the marginal abductors in aquatic feet becomes apparent. In the backward stroke of the pes the water, the resisting medium against which it strikes, is sufficient to cause the full expansion of the web. The flexores breves guard against over extension of the digits, and thus the long flexor muscle is free to act upon the ankle joint. Dr. Murie describes in the foot of the Sea-lion [1] (*Otaria jubata*) two short muscles which lie obliquely upon the under surface of the tarsus. They both arise from the scaphoid, and they are respectively inserted into the internal cuneiform, and into the base of the first metatarsal bone. He considers that they represent the adductor and flexor brevis hallucis, but as he figures a very distinct adductor for this toe, and also the fibular head of a flexor brevis hallucis, I think (as already explained) that it is more probable that they are homologous with the absent abductor hallucis and tibial head of the flexor brevis hallucis. But what has caused those muscles to assume these highly anomalous attachments? Dr. Murie states that "both are flexors"; one of the internal cuneiform upon the scaphoid and the other of the first metatarsal bone. In this manner therefore they support the tarsus and enable it to bear the strain which must be communicated to it by the backward stroke of the expanded digits through the water. In the Walrus [2] Dr. Murie found corresponding muscles, and in this animal, as we have seen, a special part of the abducting apparatus of the minimus is set aside apparently for the same purpose. This muscle stretches between the under surface of the os calcis and the base of the fifth metatarsal bone.

Let us now choose two terrestrial animals of similar habits, and which employ their feet for similar purposes, viz., the Dog and the *Thylacine*. Both these animals use their feet for progression, and it may be also occasionally for burrowing. In the latter case they employ them to clear away the earth which has been detached by their fore-paws. In both animals the feet are very similar in outward appearance, with the exception that the Dog is digitigrade, whilst the *Thylacine* is semi-plantigrade. The intrinsic muscles are disposed differently in each case. In the *Thylacine* the arrangement is typical in every respect; in the Dog the flexores breves and abductors are coalesced, and this withstanding the slow, skulking character of the *Thylacine* as compared with the highly active habits of the Dog.

Arboreal Marsupials almost invariably exhibit the typical disposition of their intrinsic muscles, *e.g.* the *Phascogale*, the Virginian Opossum, the Australian Opossum, the *Cuscus*, &c. The Koala is an exception, inasmuch as the dorsal layer is poorly represented. The arboreal Rodent, the Squirrel (*Sciurus vulgaris*) has, however, quite a different arrangement. The adductors and flexores breves are well developed, but the abductors are reduced to a single muscle, viz., the abductor minimi digiti.

[1] On the Anatomy of the Sea Lion, Trans. Zool. Soc., vol. vii. p. 579.
[2] On the Anatomy of the Walrus, Trans. Zool. Soc., vol. vii. p. 456.

From the above examples it is seen that very much the same functions may be performed by different feet by a great diversity of arrangements of the intrinsic pedal muscles. In the animals that we have compared, however, we must remember that we have only looked at the feet from one point of view, viz., that which bears chiefly upon the special mode of life adopted by the animal. We must not lose sight of the fact that the difference in structure in feet, which we might expect to find similar, may be due to many circumstances that we have not taken into account. The offices and duties required of the foot are very numerous and very diverse, and we cannot therefore classify them arbitrarily into burrowing, aquatic, terrestrial, and arboreal.

Dr. Young is of opinion that "the differentiation and development of the flexores breves" is for the purpose of providing for the maintenance of a "continuous and powerful flexion of the digits, without at the same time interfering with the free movements at the wrist." I am rather inclined to believe that the part which all the intrinsic muscles have to play is the production of the more rapid and precise movements of the digits, movements which could not be produced by muscles which arise in the forearm or in the leg, and which are inserted into the digits by means of long tendons. In a general sense, Dr. Young is decidedly correct in the observation which he makes, that those digits "which are endowed with the most independent powers, have invariably the most distinctly differentiated muscular arrangements; hence, even when the whole of the digits are supplied with the "typical" complement of muscles, the first and fifth are very commonly more favoured than the rest."

One cannot examine a large number of different Mammalian feet without being struck by the decided ordinal distinctions which the intrinsic muscles exhibit in their disposition. In Marsupialia, we have the tendency to the trilaminar disposition. In Monotremata there is the marked development of the adductors and the primitive condition of these as regards their insertion with reference to the middle line of the foot. In Carnivora the prominent feature is the coalescence (or shall we say the non-separation ?) of the flexores breves and dorsal interossei with the frequent development of an opponens minimi digiti from the plantar layer. In the Solidungula and Ruminantia, the flexores breves are converted into the suspensory ligament. In Rodentia there is the pre-eminence of the intermediate layer of the flexores breves. In the Quadrumana the muscles of the hallux are inordinately developed, and the adductor hallucis becomes split up into an oblique and transverse portion. In Homo and his more immediate allies of the Quadrumanous order, viz. the Gorilla and Orang, there is the loss of the plantar muscles, with the exception of the adductor hallucis and the loss also of certain of the heads of the flexores breves so that the remainder take on the function of the absent adductors. In the Edentata, which is composed of so many diverse forms, there is apparently no feature peculiar to all.

Nerve arrangements.—At the outset of this chapter upon the intrinsic pedal muscles we referred to the view which is held by certain anatomists, that the relationship between

"nerve-supply" and "muscle-homology" is invariable and immutable. It is well at this stage to inquire how far the nerve arrangements in the Mammalian foot bear out this doctrine.

In the great majority of cases the pedal nerves have precisely the same course and distribution. The two plantar nerves enter the sole by the hollow in the os calcis. The internal plantar nerve supplies the abductor hallucis and flexor brevis hallucis (when such muscles are present). The external plantar nerve turns outwards to reach the fibular margin of the foot, where it breaks up into a superficial and deep part. The former supplies the flexor brevis and abductors of the little toe, whilst the deep part turns inwards across the sole under cover of the plantar adducting muscles, and is distributed to all the adductors and to the other intrinsic muscles of the index, medius, and annularis. The rule therefore is, that with the exception of the flexor brevis and the abductor of the hallux, the external plantar nerve supplies all the intrinsic muscles of the foot. But this is not the invariable rule. Certain well-marked exceptions are met with.

In the Elephant the internal plantar nerve supplies the flexor brevis indicis; in the Hyrax the internal plantar nerve supplies the flexor brevis indicis, the adductor indicis, and the second dorsal interosseous muscle; in the Beaver, a still more remarkable deviation is found. From the internal plantar nerve proceed the twigs of supply for the abductor hallucis, flexor brevis indicis, flexor brevis medii, and the first and third dorsal interossei. Lastly, in the Fox-bat there is an example of the external plantar nerve encroaching upon the domain of the internal plantar by supplying a twig to the outer head of the flexor brevis hallucis.

The arrangement of the digital nerves is also not without interest. It follows a more constant plan than that of the muscular twigs. In a pentadactylous foot the internal plantar nerve gives off four digital branches, which are distributed to the hallux, the index, the medius, and the tibial side of the annularis. The external plantar nerve on the other hand provides two digital branches—one for the fibular side of the minimus, and the second for the adjacent sides of the minimus and annularis. In only one instance have I observed a marked deviation from this arrangement, viz., in the *Echidna*, in which the digital nerve for the contiguous margins of the annularis and medius comes from the deep division of the external plantar, and the twig, for the outer side of the minimus proceeds from the internal plantar.

The digital nerve for the adjacent margins of the minimus and annularis is somewhat variable in its origin. In the lower members of the Mammalian class (*Ornithorhynchus, Echidna, Cuscus, Vulpine phalanger, Paca,* &c.) this branch arises from the deep division of the external plantar, and reaches its distination by coming out from under cover of the adductor minimi digiti. In the Fox-bat, Quadrumana, and Man it springs from the superficial division of the external plantar nerve, and in its course downwards it is not covered by any muscular structure. In *Thylacine* an intermediate condition is

exhibited. The branch in question comes from the superficial division of the external plantar, but it is joined at its point of bifurcation by a large twig from the deep division.

Very few cases occur in which the plantar nerves deviate from the ordinary course. In the *Ornithorhynchus* we find the external plantar entering the foot upon the outer side of the os calcis, apart from the internal plantar. Again, in the *Echidna* the internal plantar gives off a branch which enters the foot by a similar route and replaces the superficial part of the external plantar nerve.

So constant, indeed, are these nerves in their relations that Ruge has been induced to make the generalisation that all those muscles which lie superficial to the deep division of the external plantar nerve are contrahentes. So far as I am aware this rule fails to apply to the foot in only two cases, viz., the *Dasyurus viverrinus* and *Dasyurus hallucatus*, in both of which the nerve passes under cover of one of the abductors of the minimus. The great objection to this method of classifying the adductors, however, is that it is incapable of being extended to the hand. In the Manus the deep division of the ulnar nerve passes inwards under cover of the flexor brevis minimi digiti, and also under (or through) the opponens minimi digiti, both of which, therefore, according to this generalisation would be looked upon as contrahentes or adductores.

Intrinsic muscles of the human hand.—The fact that abduction and adduction takes place in the human hand with reference to the middle digit constitutes the chief difference between the disposition of the intrinsic muscles of the Manus and pes in Man. The descriptions given of the short muscles of the thumb in works upon human anatomy are very misleading and at variance with the homologies of these muscles. The nerve supply is of itself sufficent to lead us to suspect this. In these text-books a single adductor pollicis and a flexor brevis pollicis, consisting of a superficial, and deep head, are described. The adductor and the deep head of the flexor draw their nerve filaments from the deep division of the ulnar, whereas the superficial head of the flexor is supplied by the median nerve. Bischoff many years ago pointed out the fallacy of this description, and insisted that the so-called adductor pollicis is in reality the adductor transversus (the homologue of the transversalis pedis), and that the so-called deep head of the flexor brevis is the adductor obliquus. These two muscles, which form a continuous muscular stratum, are separated from each by the entrance into the palm of the radial artery. But an inner or deep head of the flexor brevis is also present. This muscular slip, however, is not always described, and when it is noticed it has a different name applied to it, viz., the "interosseus volaris primus" of Henle. I entirely agree with Bischoff in his views upon the short muscles of the thumb; indeed, I had arrived at similar conclusions before I read his paper upon this subject. From a number of dissections made by Mr. Sheridan Delepine in the Practical Anatomy Rooms of the Edinburgh University, I am led to believe that the minute inner head of the flexor brevis pollicis is a constant muscular slip. It is quite invisible from the palmar aspect of the hand, and is best exposed from the dorsal aspect

by removing the first dorsal interosseus, or indeed by merely dividing the head of this muscle which springs from the first metacarpal bone. It is a very small muscular slip which, as Bischoff expresses it, has been "thrust into the deep," by the largely developed adductor obliquus. It lies in series with the palmar interossei.

In the tabular view, which is given in the eighth edition of Quain's Anatomy, of Muscular Homologies in the Upper and Lower Limbs, the relations between the muscles of the thumb and great toe are stated with tolerable accuracy with the exception that the position of the two heads of the flexor brevis pollicis is reversed. The following is an extract from that table :—

Flexor brevis pollicis, inner head, . .	Flexor brevis hallucis.
Flexor brevis pollicis, outer head, . .	Adductor hallucis obliquus.
Adductor pollicis, ...	Transversalis pedis.

In place of this the table should be constructed thus :—

Flexor brevis pollicis, ...	Flexor brevis hallucis.
(*a*) Radial head, ...	(*a*) Tibial head.
(*b*) Interosseus primus volaris, . .	(*b*) Fibular head.
Deep or ulnar head of flexor brevis pollicis, . . . } . .	Adductor obliquus hallucis.
Adductor pollicis, ... {	Adductor transversus hallucis (*i.e.* transversalis pedis).

II. The question now arises: If the intrinsic muscles of the foot are laid down in three layers, to which of these does the opponens muscle belong ?

It is necessary, however, before we inquire into this point that we should have a clear understanding what the muscles are to which the term "opponens" should be applied. We need not look to function for a true definition, for many of the opponens muscles have little or no opposing action. It is clearly the insertion which must be taken as the distinguishing feature, and we may define the term as being one which may be properly applied to any intrinsic muscle, which is inserted into the shaft of a metatarsal bone.

An opponens hallucis is a very rare occurrence. In his memoir upon the *Hylobates leuciscus* Bischoff remarks that among the Apes he has "only found it as a peculiar speciality in the Orang and Macacus." In the report of Lecture xvii. upon the Structure and Classification of Mammalia, delivered by Professor Huxley before the Royal College of Surgeons in 1864, and published in the Medical Times and Gazette, we find the following passage (vol. i. p. 596):—"There was present in the specimen (Orang), dissected by Professor Huxley, an opponens hallucis, inserted into the middle third of the meta-

tarsal of the hallux; this has not been described by other authors, nor indeed is there any trustworthy evidence of the existence of such a muscle in any of the Mammalia."

Macalister (Proceedings of the Royal Irish Academy, vol. i., 2nd series, page 506) describes an opponens hallucis in the Gorilla. Bischoff, however, was unable to find such a muscle in the specimen which he dissected (Beiträge zur Anatomie des Gorilla, p. 31, *loc. cit.*).

An opponens minimi digiti is very common, and often very strongly marked. It may be regarded as belonging in some instances to the adducting or plantar layer, and in others to the intermediate or flexor layer. Thus Ruge has conclusively shown that in the human foot (when present) it is a special development of the flexor brevis minimi digiti. He says:[1] "in the earliest periods in the development of the human foot every trace of an opponens of the little toe is awanting. First by the aberration of fibres of insertion of the flexor brevis on to the head, and outer surface of the fifth metatarsal the beginning of an opponens becomes gradually noticeable; in older subjects this becomes further developed, and more turned in direction until, finally, the whole outer surface of the fifth metatarsal serves for the insertion of the muscle. In preparations from later embryonic periods, the flexor and opponens fibres appear separate in their distal portions, so that the opponens reaches a greater and greater degree of independence the further the process of separation goes on. At the same time the opponens, now distinct, comes to lie under cover of the flexor. This condition remains throughout life, but still the muscle in the adult shows a decrease in its circumference, and may even have disappeared altogether. These conditions occur so very frequently that I may say they are the rule."

In the Lemur and in the phalanging marsupials the opponens minimi digiti has apparently the same origin as in man.

On the other hand many of the digitigrade Carnivora afford a beautiful example of its association with the plantar layer. We have already seen it in the Dog, Cat, Puma, Leopard, Lion, Otter, and Pole-Cat, arising in common with the adductor minimi digiti.

III. The last point that we have to consider is one of great interest, viz., that the relation of the intrinsic muscles of the foot to the metatarsus in many animals corresponds to transitory conditions in the foot of the human embryo.

Ruge in his memoir upon the Development of the Muscles of the Human Foot shows that the interossei muscles in the foot of the early embryo are plantar in position, and that the upward growth of the dorsal interossei and the formation of the interosseous spaces take place as a subsequent and gradual step. In three of the diagrams which illustrate the text he gives representations of sections through the metatarsus at three

[1] The Development of the Muscles of the Human Foot (*loc. cit.*), p. 131.

different periods of development. In the first the metatarsal bones, with the exception of the first two, are in close apposition, and in consequence all the interosseous muscles, excepting the first dorsal, are plantar in position. The second diagram is from a foot somewhat more advanced. It shows that as development progresses the metatarsal bones separate from each other, and that simultaneously with this the dorsal interossei begin to shoot up between them like wedges. The third illustration gives a view of the relative position of the muscles and metatarsal bones as they are to be seen in the adult. The bones are widely apart from each other, and the muscles have reached the dorsum of the foot.

Among the lower mammals there are many animals which in their adult condition correspond exactly with the first stage of the human embryo in the relation of their intrinsic pedal muscles to the metatarsus. Perhaps the Dog and the Dasyure are the best examples that I could quote. In these the metatarsals are closely compressed together, and the muscles are entirely plantar in position (Pl. VIII. fig. 4).

The majority of animals never reach beyond the second stage of the human embryo in this respect. Let us take the foot of the Leopard as an example. In this animal, the metatarsal bones, whilst they are closely applied to each other towards the tarsus, open out slightly from each other towards their phalangeal extremities; and in the intervals between them the thin sharp edges of the dorsal interossei may be seen reaching half-way up the interosseous spaces (Pl. VIII. fig. 7).

Comparatively few animals correspond with the third or adult condition of the human foot; still certain of the Apes approach very closely to Man in this respect.[1]

It is curious to find in an animal so low as the Duck-bill *Platypus* a closer approach to Man than in the vast majority of mammals. The dorsal interossei reach the dorsum of the foot, and, moreover, the second and third are two-headed.

But there is also a relation between the human embryo and many of the adult animals in the mode of origin of the dorsal interossei. Ruge points out that in the early embryo these muscles are one-headed, and that it is only in a later stage that they acquire their bipenniform character and their origin from the metatarsal shafts. How similar is this to what we have seen to be the permanent condition in the great majority of mammals.

[1] Mr. Champneys, when he wrote his well known paper upon the Chimpanzee and Anubis (Jour. Anat. and Phys., vol. vi. p. 207), had a very clear conception of the different conditions which the intrinsic pedal muscles presented to the metatarsus. The following is a footnote appended to his paper:—"Duvernoy remarks that in the Gorilla, as I found in Chimpanzee, the dorsal interossei are not so dorsally placed as in Man. Moreover, this fact was plainly set forth in the hand of my Chimpanzee, in which parts of the dorsal interossei were so divaricated palmarly as to be positively palmarly, and not at all dorsally, placed. In the lower Monkeys, as Cebus, *Innuus nemestrinus*, and in Anubis, there are really no true dorsal interossei, but two layers of plantar, the more dorsally lying of which we may take, if we please, to represent the dorsal interossei. The more plantarly placed resemble the interossei of the Carnivora, as Church remarks. We, therefore, have an ascending series from that case where the dorsal interossei are plantarly placed (represented by the Cebus and Anubis, the more plantarly placed resembling those of the Carnivora), to the Anthropoid Apes, where these are more dorsal, and thus to Man, where they are more dorsal still. This dorsal migration of the interossei is very interesting."

The Nerves of the Hind-limb of the *Thylacine* and *Cuscus*.

So much stress is now laid upon "nerve supply" in the determination of "muscle homology," that it becomes a matter of importance to add in every way possible to our knowledge of the comparative anatomy of the nervous system. With this end in view I have examined with great care the arrangement of the nerves in the hind-limb of the *Thylacine* and *Cuscus*.

Lumbar plexus.—In both the *Thylacine* and *Cuscus* the anterior primary divisions of the lumbar nerves are six in number, but the part which these play in the formation of the lumbar plexus differs in the two animals. In *Thylacinus* (Pl. V. fig. 5), the plexus is formed by the first four nerves, whilst the fifth and sixth lumbar nerves join to constitute the lumbo-sacral cord. In *Cuscus* (Pl. V. fig. 6) the first lumbar nerve is quite independent of the plexus, and is expended like the last dorsal in the abdominal wall, whilst the plexus is formed by the union of the 2nd, 3rd, and 4th nerves, and the greater part of the fifth nerve. The lumbo-sacral cord in this case is composed of the remaining part of the fifth and the whole of the sixth nerve. In both animals the plexus has the usual looped arrangement.

Branches.—In *Thylacinus* (Pl. V. fig. 5) the branches of the plexus come off in the following manner:—(1) from the 1st lumbar nerve a large branch to the abdominal parietes; (2) from the loop between the 1st and 2nd, two twigs to the abdominal parietes; (3) from the loop between the 2nd and 3rd, the genito-crural nerve (*g.c.*); (4 from the loop between the 3rd and 4th, the external cutaneous nerve (*e.c.*); (5) from the 3rd and 4th, the anterior crural (*a.c.*), and obturator nerves (*o*); (6) from the 2nd, 3rd, and 4th, twigs to the psoas.

In the *Cuscus* (Pl. V. fig. 6) the branches have the following origin:—(1) From the 2nd, a branch to the abdominal parietes; (2) from the 3rd, a long nerve to the abdominal wall, and a small twig to the psoas (*p*); (3) from the loop between the 3rd and 4th, the genito-crural (*g.c*); (4) from the 3rd and 4th, the external cutaneous (*e.c*); (5) from the 3rd, 4th, and 5th, the anterior crural (*a.c*); (6) from the 4th and 5th, the obturator (*o*).

If we exclude the 1st lumbar nerve and enumerate the others from the second backwards, there is a striking resemblance between the lumbar plexus in the *Cuscus* and that in Man, both in its mode of formation and in the manner in which the branches take origin

The three branches which are given off both in *Thylacinus* and *Cuscus* to the abdominal parietes correspond to the ilio-inguinal and ilio-hypogastric in man, and they are distributed to the muscles and skin upon the same plan.

The genito-crural (Pl. V. figs. 5 and 6, *g.c* and Pl. IV. figs 1 and 4, *g.c.n*) proceeds downwards through the psoas parvus to reach the large cremaster, into the deep surface

of which it sinks. In the male it is entirely expended in the supply of this muscle, but in the female *Thylacine* it soon emerges from midst the muscular fibres of the cremaster, and is continued upon the superficial aspect of the muscle through the external abdominal ring, and under cover of the sphincter muscle of the marsupium to the region of the nipples, where it breaks up into a series of fine terminal twigs (Pl. IV. fig. 4, *g.c.n*). These are doubtless for the supply of the mammary gland, which in the specimen I dissected (evidently a young virgin) could not be detected.

The external cutaneous (Pl. V. figs. 5 and 6, *e.c*) is distributed to the skin on the outer aspect of the thigh. It pierces the abdominal wall near the crest of the ilium, and in the *Cuscus* it was observed to give several fine twigs to the panniculus carnosus.

The anterior crural[1] (Pl. IV. fig. 1, *a.c.n*, and Pl. V. figs. 5 and 6, *a.c*) in the *Thylacine* arises in common with the obturator from the 3rd and 4th lumbar nerves, whilst in the *Cuscus* it has an independent origin by two roots from the 3rd, 4th, and 5th nerves. In both it proceeds backwards in the interval between the psoas parvus and magnus, and, entering the thigh, at once breaks up into a large number of muscular and cutaneous branches.

During its course within the abdomen it gives a plentiful supply of twigs to the psoas and iliacus muscles, and in the *Cuscus* a long slender twig (Pl. V. fig. 6, *s*) was observed to spring from it, which pierced the abdominal wall to reach the sartorius. In the thigh muscular branches are distributed to the sartorius, the pectineus, and the various parts of the quadriceps extensor muscle. The cutaneous branches are the long saphenous nerve and three or four twigs to the skin upon the anterior and inner aspects of the thigh.

The long saphenous nerve (Pl. IV. fig. 1, *c.c.n*) is a very constant nerve in all mammals, although it varies very considerably in bulk and in its area of distribution. It descends upon the inner aspect of the thigh and leg in company with the vein of the same name, and dispenses numerous twigs to the skin. In the *Thylacine* its terminal twigs are lost in the integuments over the internal ankle. In the *Cuscus*, however, it is continued downwards in front of the inner malleolus for the supply of the skin on the dorsal aspect of the broad opposable hallux (Pl. VI. fig. 8, 3). Here it is joined by a twig from a special nerve to the hallux (Pl. VI. fig. 8, 4) (derived from the internal popliteal), and breaks up into three filaments; of these one runs along each margin of the digit, whilst the third proceeds along its middle line. On the dorsum of the foot it effects a communication with the musculo-cutaneous nerve.

A glance at the beautiful figures which accompany Ruge's paper[2] upon The Group of

[1] In the Ass, in which the lumbar nerves are six in number, the anterior crural nerve springs from the 3rd, 4th, 5th, and 6th nerves; and in the Fox, in which the lumbar nerves are seven in number, it takes origin from the 4th, 5th, and 6th (Swan's Comparative Anatomy of the Nervous System).

[2] Morphol. Jahrbuch, 1878.—Untersuchung über die Extensorengruppe am Unterschenkel und Fusse der Säugethiere von Dr. Georg Ruge, Heidelberg.

Extensors on the Leg and Foot of Mammalia, will show how variable the long saphenous nerve is in respect to its terminal distribution. In the *Mustela foina, Meles vulgaris, Felis domestica, Cercopithecus,* it ends before it reaches the foot; in the *Ornithorhynchus paradoxus, Didelphys virginiana, Nasua socialis, Felis leo, Inuus cynomolgus, Cebus,* and Orang it reaches the dorsum of the foot, and supplies filaments to the skin of the hallux. In none of these, however, excepting the *Ornithorhynchus,* is its area of supply on the dorsum of the foot so wide as in the *Cuscus.*

The obturator nerve[1] (Pl. V. figs. 5 and 6, *o*, and fig. 4, 1; also Pl. IV. fig. 1, *o.n*) is small in comparison with the corresponding nerve in man. It arises in *Thylacinus* in common with the anterior crural, and in *Cuscus* by two roots from the 4th and 5th lumbar nerves. Its course and distribution is the same in both animals. Quitting the pelvis through the upper part of the thyroid foramen it supplies branches to the obturator externus and the adductors longus and brevis, and ends by sinking into the substance of the gracilis. It gives no twigs to the pectineus or adductor magnus, neither does it divide into a superficial and deep division.

Sacral plexus.—In *Thylacinus* (Pl. V. fig. 5) the sacral plexus is apparently formed entirely by the lumbo-sacral cord, which is prolonged into the gluteal region as the great sciatic nerve (*g'.s*). No communication could be traced between this great nervous trunk and the first sacral nerve. Before quitting the pelvis it gives origin to (1) the superior gluteal (*s.g*); (2) a special branch to the ecto-gluteus (*g.m*); (3) a special nerve to the hamstring muscles (*h*); (4) branches to the pyriformis.

From the 1st sacral nerve the pudic (*p*) and small sciatic nerves (*s.s*) take origin.

In the *Cuscus* the arrangement is quite different (Pl. V. fig. 6). The lumbo-sacral cord is joined by the whole of the 1st sacral nerve, and a small portion of the 2nd sacral nerve, and a large nervous band is thus formed. This divides into two unequal parts, of which the larger is the great sciatic (*g'.s*) whilst the smaller gives origin to (1) a special branch to the ecto-gluteus (*g.m*); (2) the small sciatic (*s.s*); (3) the special nerve to the hamstrings (*h*).

The superior gluteal nerve (*s.g*) arises from the lumbo-sacral cord before it is joined by the sacral nerves, and the pudic (*p*) comes from the 2nd sacral nerve.

Nerves to ecto-gluteus.—The several parts of this muscle (the representatives of the gluteus maximus in man) are supplied differently in the two animals. In *Thylacinus* one large nerve enters the gluteal region through the anterior part of the great sacro-sciatic foramen, and breaks up into branches for the supply of the four constituent parts of the ecto-gluteus (Pl. IV. fig. 5, *g.n*). In *Cuscus* this branch is much smaller in size, because the ecto-gluteus also draws twigs from the small sciatic.

Superior gluteal nerve (Pl. III. fig. 1, *s.g.n*).—After emerging from the pelvis through the great sacro-sciatic foramen, this nerve ramifies between the meso-gluteus and

[1] In the Fox the obturator springs from the 5th and 6th nerves, and in the Ass from the 4th, 5th, and 6th (Swan).

endo-gluteus, and supplies filaments to both. In *Cuscus* a long slender twig can be traced downwards to end in the ecto-gluteus, where it folds round the lower margin of the meso-gluteus to become continuous with the endo-gluteus. The fibres to which this twig is distributed undoubtedly represent the tensor fasciæ femoris.

Small sciatic.—In the *Thylacine* (Pl. IV. fig. 5, *s.s.n*) this is a purely cutaneous nerve, whilst in the *Cuscus* (Pl. III. fig. 1, *s.s.n*) it also contains motor fibres which it dispenses to the ecto-gluteus. Emerging from the pelvis through the great sacro-sciatic foramen in front of the pyriformis it makes its entrance into the gluteal region under cover of the meso-gluteus. It soon appears at the posterior border of this muscle, and then proceeds backwards upon the pyriformis and ischio-femoral muscles covered by the ecto-gluteus. Finally, dipping under the superficial vertebral origin of the biceps muscle it becomes superficial on the back of the thigh, and is distributed to the skin as low down as the upper part of the leg.

Nerve to hamstrings (Pl. III. fig. 1, *h.n*, and Pl. IV. fig. 5, *h.n*).—This is hardly an appropriate name for this nerve, seeing that it has a much wider distribution than to the hamstring muscles, but it is difficult to suggest a better. It is a large nerve, composed entirely of motor fibres. It enters the gluteal region through the great sacro-sciatic foramen, and proceeds backwards upon the endo-gluteus, and under cover of the pyriformis. At the lower border of the latter muscle it gives off a large branch (Pl. III. fig. 1, *g.n*)—the representative of the nerve to the quadratus femoris in man,—and then continues downwards under the ischio-femoral muscle to the under surface of the biceps muscle. Here it breaks up into a large number of branches for the supply of the biceps and its various accessory parts, the semitendinosus and the semi-membranosus.

In the *Cuscus* the nerve to the quadratus femoris sinks into the substance of the gemelli muscles, and is continued backwards through their muscular fibres. Issuing from the midst of the gemellus inferior, it is carried downwards under cover of the quadratus femoris to the adductor magnus. In this course it supplies twigs to the gemelli, quadratus femoris, and probably to the obturatus internus, whilst it ends in the adductor magnus, and constitutes its sole nerve of supply.

In the *Thylacine* the distribution of the nerve to the quadratus is precisely similar to that in the *Cuscus*, but its relations to the gemelli muscles are somewhat different. Each gemellus consists of a superficial and deep part, and the nerve in passing backwards passes between the two portions of the superior muscle, and then under cover of the obturator internus and both portions of the inferior gemellus.

In *Thylacinus* and *Cuscus*, therefore, the adductor magnus is associated by its nervous supply with the quadratus femoris, and it draws branches from neither of its usual sources, viz., the great sciatic and the obturator nerves. The advocates for the theory that nerve-supply points infallibly to the homology of a muscle will find this a difficult fact to solve. Of course it might be explained by supposing that the adductor magnus

is a compound muscle, consisting of a part belonging to the adductor group, which in this case has fused with the large adductor brevis, and a part derived from the flexor group, which in the present instance is independent, and receives its nerve fibres from the same source, but through a different nerve-strand, viz., the nerve to the quadratus.

The adducting group of muscles holds an intermediate position in the thigh, and in Man it seems to merge in front with the extensors, and behind with the flexors. The nerve supply points to this. Thus the pectineus is furnished with twigs from the obturator and anterior crural nerves, whilst the adductor magnus is supplied by the obturator and great sciatic nerves.

Pudic (Pl. III. fig. 1, *p.n*, and Pl. IV. fig. 5, *p.n*).—This is a small nerve which runs backwards under cover of the pyriformis muscle, and then through the small sciatic notch to the perineum. In the gluteal region of the *Thylacine* it gives a small twig to the posterior of the two vertebral portions of the biceps, whilst in *Cuscus* it receives a communicating twig from the nerve to the hamstrings (Pl. V. fig. 6, *p*).

Great sciatic (Pl. III. fig. 1, and Pl. IV. fig. 5, *g.s.n*).—The great sciatic enters the gluteal region under cover of the meso-gluteus, and proceeds backwards upon the pyriformis, obturator internus and gemelli, and the ischio-femoral muscle, to the under surface of the biceps. Half-way down the thigh it ends by dividing in three, viz.:—(1) internal popliteal; (2) external popliteal; (3) external saphenous. It gives off no collateral branches.

External saphenous (Pl. V. fig. 2, 1).—This large nerve proceeds downwards under cover of the biceps to the outer back aspect of the leg, along which it runs to the external maleolus. It is continued behind this bony prominence to the outer margin of the pes, where it ends as the fibular dorsal collateral branch of the little toe (Pl. VI. fig. 8, 1). It supplies (*a*) muscular, (*b*) communicating, and (*c*) cutaneous twigs.

The muscular branches are different in the two animals. In *Thylacinus* it sends a twig to the lower part of the biceps. In *Cuscus* it gives a branch to the inner head of the gastrocnemius, and another to the fibular part of the vertebral portion of the biceps.

The communicating branches are—(1) a strongly marked twig, present in both animals, which passes inwards under cover of the tendo-Achillis and the tendon of the plantaris to join the external plantar nerve (Pl. V. fig. 2, 2); (2) in the *Cuscus* a twig to the musculo-cutaneous nerve on the dorsum of the foot (Pl. VI. fig. 8).

The cutaneous twigs are very numerous, and supply the skin over the outer aspect of the leg and foot.

Internal popliteal (Pl. VI. fig. 8, 4).—This is the largest of the three terminal divisions of the great sciatic. In *Thylacinus* it sends off behind the knee joint, and between the heads of the gastrocnemius a large number of muscular branches to the superficial and deep muscles on the back of the leg, and then divides into the external and internal

plantar nerves. The gastrocnemius receives two of its muscular branches—one to each of its heads, whilst the popliteus appropriates no less than three. These enter its upper, middle, and lower portions respectively. The second of these proceeds downwards in the interval between the tibialis posticus and flexor longus digitorum, and the third between the tibialis posticus and the flexor longus hallucis.

In the right leg the plantaris was supplied by two twigs from the external plantar nerve.

In *Cuscus* the same muscular branches (Pl. V. fig. 2, 5) are given by the internal popliteal, but the nerve ends by dividing into three, viz.:—(1) a nerve to the hallux (7); (2) internal plantar (6); (3) external plantar (3).

The *nerve of the hallux* is present only in *Cuscus*. It runs downwards alongside the internal plantar nerve between the superficial and deep muscles on the back of the leg. Near the ankle it diverges inwards, leaves the internal plantar nerve, and is distributed to the hallux by a dorsal and a plantar branch (Pl. VI. fig. 8, 4, and fig. 5, 1). The dorsal branch joins the inner of the three terminal twigs of the internal saphenous, and is distributed upon the tibial margin of the digit; the plantar branch pierces the inner edge of the abductor hallucis which it supplies, and then forms the inner collateral plantar twig for the hallux (Pl. VI. fig. 7, 1). This branch in one limb was joined by a filament from the internal plantar nerve.

Internal plantar nerve.—The internal plantar nerve runs down the back of the leg between the superficial and deep muscles, and enters the sole by passing behind the internal maleolus.

In *Thylacinus* it now proceeds along the inner margin of the flexor brevis digitorum, and, sinking under cover of the plantar fascia, divides into three digital branches, which are distributed in the following manner (Pl. VI. fig. 4, 2):—(1) the first goes to the tibial side of the index; (2) the second, which is reinforced by a long slender twig from the deep division of the external plantar, bifurcates to supply the adjacent margins of the index and medius; (3) the third divides and supplies the contiguous margins of the medius and annularis. From the main trunk several small twigs are given to the flexor brevis digitorum, whilst from the digital nerves no fewer than ten branches are supplied to the plantar pad.

In *Cuscus* the internal plantar at the ankle sends a recurrent branch (Pl. V. fig. 2, 8) to the flexor brevis digitorum, and a communicating and reinforcing twig to the plantar portion of the nerve to the hallux. It then enters the sole by passing under cover of the plantar cartilage, and, after sending branches to the flexor brevis hallucis, divides into three digital branches, which have the following distribution:—(1) the first bifurcates to supply the adjacent sides of the hallux and index; (2) the second divides for the supply of the contiguous and adherent sides of the index and medius; and (3) the third goes to the adjacent sides of the medius and the large annularis, and in addition communicates with the inner digital branch of the external plantar (Pl. VI. fig. 7, 2).

External plantar nerve (Pl. V. fig. 2, 1).—This nerve proceeds down the back of the leg in close company with the internal plantar, and near the heel it is joined by the large reinforcing branch from the external saphenous. The further course of the external plantar differs so much in the two animals that a separate description for each becomes necessary.

In *Thylacinus* (Pl. VI. fig. 1, 1, and fig. 4, 1) it lies close against the os calcis, and entering the sole diverges to the outer margin of the foot under cover of the flexor brevis digitorum. Here it gives twigs to the abductor ossis metatarsi minimi digiti and the long abductor minimi digiti, and then divides into (*a*) a superficial, and (*b*) a deep portion.

The superficial division is a purely cutaneous nerve, and almost immediately divides into two digital branches, viz.:—one to the fibular side of the minimus (Fig. 1, 4), and a second which bifurcates to supply the adjacent margins of the minimus and annularis (3). The twig which goes to the tibial side of the minimus is reinforced by a slender filament from the deep division of the external plantar nerve.

The deep division of the external plantar (Fig. 1, 2) turns inwards, and, disappearing from view under cover of the great flexor tendon, insinuates itself between the plantar or adductor, and the intermediate or flexor groups of intrinsic muscles, where it divides into an outer and an inner branch. The external branch proceeds downwards, and after giving twigs to the short abductor minimi digiti, the flexor brevis minimi digiti and the fourth dorsal interosseous muscle (*i.e.*, the abductor annularis), it emerges from under cover of the adductor minimi digiti in the cleft between the minimus and annularis, and joins the tibial digital nerve to the minimus. The internal branch is carried transversely across the sole upon the intermediate muscles, and gradually exhausts itself in the supply of the other intrinsic muscles of the foot. It also effects a communication by means of a long slender filament with the digital nerve from the internal plantar to the adjacent margins of the index and medius.

In *Cuscus* (Pl. VI. fig. 5, 2, and fig 7, 3) the external plantar nerve gains the sole by passing under cover of the ligament which binds the plantar cartilage to the tuber of the os calcis, and immediately divides into a superficial and a deep division.

The superficial branch proceeds outwards and downwards over the abductors of the minimus, and ends as the fibular plantar nerve of this digit.

The deep branch supplies twigs to the three abductors and the opponens of the minimus, and passing under cover of the last muscle reaches the interval between the plantar and intermediate muscles. Here it divides as in the *Thylacine* into an outer and inner branch.

The external branch emerges from under cover of the adductor minimi digiti, and divides to supply the adjacent sides of the minimus and annularis. The internal branch ends by supplying twigs to all the intrinsic muscles, with the exception of (1) the abductors

and opponens of the minimus; (2) the flexor brevis hallucis, which receives its twigs from the internal plantar; and (3) the abductor hallucis, which is supplied by the nerve to the hallux.

External popliteal (Pl. V. fig. 3, 1).—In *Thylacinus* this nerve gives off no branches in the thigh, but diverging outwards pierces the outer head of the gastrocnemius, and at once divides into its superficial and deep portions, *i.e.*, the musculo-cutaneous and anterior tibial.

The *musculo-cutaneous*, unlike the corresponding nerve in Man, is intended for the supply of skin alone. It proceeds downwards upon the anterior aspect of the leg, dispensing filaments as it goes, and ultimately it reaches the dorsum of the foot where it ends in four branches, which have the following distribution:—(1) the first (counting from the inner margin of the foot) constitutes the tibial branch upon the dorsal aspect of the index; (2) the second joins the fibular dorsal branch of the index, which is derived from the anterior tibial; (3) the third joins the fibular dorsal branch of the medius, which also comes from the anterior tibial; (4) whilst the fourth bifurcates to supply the adjacent margins of the minimus and annularis (Pl. VI. fig. 3, 2).

The *anterior tibial* nerve proceeds forwards between the two heads of the peroneus longus, and then pierces the peroneus brevis and extensor communis digitorum to reach the interval between it and the tibialis anticus. It is now continued downwards upon the interosseous membrane, and, passing under cover of the upper annular ligament, reaches the dorsum of the foot. Here it ends by dividing into two dorsal digital branches. These are distributed thus:—(1) the first divides to supply the adjacent sides of the index and medius, whilst (2) the second bifurcates to end upon the contiguous margins of the medius and annularis (Pl. VI. fig. 3, 1).

Muscular branches.—Between the heads of the peroneus longus the anterior tibial gives off a great number of muscular branches which go to the two heads of the peroneus longus, the peroneus brevis, the extensor brevis minimi digiti, upon which the nerve lies, the common extensor, and the tibialis anticus. A long slender twig also proceeds downwards to supply the two lower portions of the extensor brevis. Whilst the nerve lies between the tibialis anticus and the common extensor it gives additional twigs to the inner part of the latter, which might be considered as an indication that the absent extensor longus hallucis is fused with the extensor communis digitorum.

In the *Cuscus* the external popliteal does not pierce the outer head of the gastrocnemius. At the head of the fibula it divides into the musculo-cutaneous and anterior tibial (Pl. V. fig. 3, 1).

The musculo-cutaneous, in passing down the leg, supplies a few twigs to the biceps, under cover of which it runs. No branches, however, are given to the peroneal muscles. On the dorsum of the foot it breaks up into four branches which supply dorsal digital

twigs to both sides of all the toes, with the exception of the hallux and the outer margin of the minimus (Pl. VI. fig. 8, 2).

The anterior tibial (Pl. V. fig. 3, 2) in the *Cuscus* is a purely motor nerve, and differs from that in the *Thylacine* by ending on the dorsum of the foot and supplying the extensor brevis of the index and medius, which in this animal has wandered downwards so as to lie upon the dorsum of the foot.[1] In the front of the leg the nerve lies between the extensor longus hallucis and the tibialis anticus.

The comparative anatomy of the external popliteal nerve has recently received special attention from Dr. Georg Ruge in his elaborate memoir upon the extensor muscles of the leg and foot in Mammalia. He examined three marsupials, viz., the *Didelyphys virginiana*, the *Didelyphys cancrivora*, and the *Dasyurus hallucinatus*. In all these the general arrangement of the nerve was very similar to that which I have described as existing in the *Thylacine* and *Cuscus*. There seems to be, however, a great variation in the relative distribution of the musculo-cutaneous and anterior tibial to the skin on the dorsum of the foot. In *Dasyurus* as in *Cuscus* the anterior tibial is purely motor, and although it reaches the dorsum of the foot it gives no branches to the integument. In *Didelyphys*, as in the *Thylacine*, the anterior tibial combines a large proportion of sensory fibres with its motor fibres. Thus in *Didelyphys virginiana* it supplies the adjacent sides of the index and medius, and also the fibular side of the hallux, whilst in *Didelyphys cancrivora* it sends twigs to both sides of the index and the tibial side of the medius. This combination of fibres in the anterior tibial, as Ruge shows, seems to be the more usual disposition throughout Mammalia generally. In some animals, indeed (as for instance the *Ateles*), the anterior tibial appears almost to supplant the musculo-cutaneous as the nerve of supply to the dorsal aspect of the digits.

Ruge is a firm believer in the invariable and immutable relationship between "nerve-supply" and "muscle-homology."

Perhaps, however, the strongest evidence of any against the immutability of nerve-supply is provided by Dr. Ruge himself.[2] Thus in the *Ornithorhynchus* he finds the tibialis anticus and the inner portion of the extensor longus hallucis supplied by a branch from the anterior crural, which is prolonged downwards to its destination over the external condyle of the femur. To account for this, he assumes that "the internal part of the extensor longus hallucis and the tibialis anticus are not homologous to the similarly named muscles" in other animals, but "belong rather to the extensor group of the thigh." He believes that the fibres which are supplied by the anterior crural nerve are gradually abolished, and that their place is taken by the external muscles of the leg.

[1] In the *Vulpine phalanger* the anterior tibial on the dorsum of the foot is not expended entirely upon the extensor brevis, but is continued onwards to supply the skin upon the inner side of the index. It likewise sends many twigs to the integument in the interval between this digit and the hallux, and it communicates with the musculo-cutaneous.

[2] *Loc. cit.*

With the first part of this hypothesis I am inclined to agree, viz., that the innervation of these muscles points to their probable derivation from the extensor muscles of the thigh; but I cannot accept the second part of the theory, that the muscles thus derived are replaced by others similarly situated and similarly attached. It is much more reasonable to suppose that the distribution of the peroneal nerve is gradually extended so as to include these muscles; that, in fact, the peroneal nerve invades the territory of the anterior crural in the same manner as we have seen the external plantar nerve encroach upon the domain of the internal plantar.

In the nervous arrangements in the hind-limb of the *Thylacine* and *Cuscus* there are facts which also require explanation if we are to accept these views as to the relation of nerve-supply to muscle-homology. Thus the biceps and its accessory parts receives twigs from (1) the pudic; (2) the nerve to the ham-strings; (3) the external saphenous; (4) the musculo-cutaneous: the adductor magnus is entirely supplied by the nerve to the quadratus femoris; and the inner head of the gastrocnemius in the *Cuscus* receives a twig from the external saphenous. If the source in the spinal cord from which the nerve fibres are derived is invariably the same, it is at least certain that the nerve-strands through which the fibres reach the muscle are often very different.

From the facts that I have brought forward, I think that we are entitled to conclude that the doctrine of the invariable relation between nerve-supply and muscle-homology is an erroneous one, and contrary to existing fact.[1] The value of this feature, however, in the determination of the history of a muscle cannot be overrated. Indeed, it is hardly equalled in importance by the "insertion."

Lastly, I consider that it is not at all unlikely—indeed, that it is highly probable—that the source in the brain or spinal cord from which the nerve fibres, destined for the supply of a certain muscle, are derived is invariably the same. Of this, however, we have little proof. It is a matter of certainty, as we have seen, that these fibres may adopt different nerve-strands in order to reach the muscle. Even in the human body great numbers of examples of this may be quoted. Thus the long buccal nerve has been

[1] Since the above was written, after, indeed, it was published in the form of an abstract (Relation of Nerve-Supply to Muscle-Homology, Jour. Anat. and Phys., vol. xvi.), a highly important paper by Dr. Hans Gadow has appeared, enlitled "Beiträge zur Myologie der hinteren Extremität der Reptilien" (Morpholog. Jahrbuch, 1881). It is very satisfactory to find that, although a pupil of the Heidelberg school from which the doctrine of the immutability of nerve-supply originally emanated, he has arrived at results very similar to my own. Working, however, at lower forms than those offered by the Mammalian order he has had a better opportunity afforded him of clearing up the question. In my investigations I have been led to believe that wherever a muscle possessed a double nerve-supply this pointed to the amalgamation of two originally distinct muscles. Dr. Gadow, however, has proved that this interpretation only applies to comparatively few cases. In mammals it is rare to meet with a muscle which draws its nerve-supply from two different sources; in Man the adductor magnus, the pectineus and brachialis anticus are the best examples of this, and we have met with several other instances in the lower members of the group. In the lower animals, however, it is an extremely common occurrence, and Dr. Gadow has shown that the percentage of double-nerved muscles diminishes as we ascend the animal series from the Reptilia, through the birds, up to mammals; whilst at the same time the number of muscles increases. He concludes, therefore, that in the majority of cases double-nerved muscles show the original state, and that these muscles afterwards may become single-nerved muscles by splitting up into two or more separate factors.

observed by Professor Turner to proceed from the superior maxillary division of the fifth;[1] again, every demonstrator of anatomy has observed the descendens noni taking its origin from the vagus instead of the ninth nerve; and the frequency of the accessory obturator and the accessory phrenic nerves is a fact of common knowledge. The Cetacea afford us a very striking illustration. The absence of functional hind-limbs and the massing of the muscles in the posterior part of the animal into four great columns, which are situated one upon each aspect of the spine, give rise to a corresponding adaptation of the nerves. Thus we find that the lumbo-caudal nerves, after giving off branches to the genitals and the abdominal wall, arrange themselves in four nerve-cords, which extend backwards upon the vertebræ to the tail. Each cord is developed in relation to one of the four fleshy columns.[2] The arrangement is peculiar to the Cetacea, and probably also the Sirenia.

Thoracic Viscera.

The thoracic viscera were examined in each specimen that was put into my hands, viz., in the *Thylacine*, the *Dasyure* (*Dasyurus viverrinus*), *Cuscus*, *Vulpine phalanger* and *Phascogale*. I now propose giving a sketch of the peculiarities which were noted.

Pericardium.

In *Thylacinus* the pericardium is oval or fusiform in shape—considerably narrower behind than in front. Posteriorly the fibrous layer presents a slight attachment to the diaphragm, whilst anteriorly it is lost upon the coats of the aorta and great vessels. Two indefinite fibrous bands, the sterno-pericardiac ligaments, bind its lower surface to the upper aspect of the sternum. In addition to the usual vessels the fibrous pericardium is pierced, in front of the root of the left lung, by the left superior vena cava. The serous pericardium reaches the surface of the heart in the usual manner. There is, however, no trace of the vestigial fold of Marshall.

In the *Dasyure*, *Phalanger*, and the *Phascogale*, the fibrous pericardium presents no direct attachment to the anterior surface of the diaphragm. In *Cuscus*, however, a distinct fibrous band passed between these structures. This was not observed in the other animals. In other respects the pericardium of each agrees with that of the *Thylacine*.

Heart.

Owen considers the Marsupial heart to be distinguished by three leading peculiarities, viz., (1) a bifurcation of the appendix of the right auricle into two angular processes which embrace the root of the aorta; (2) the absence of the annulus and fossa ovalis—a condition which doubtless points to the short intra-uterine life of the fœtus, and (3) the absence of the terminal aperture, in the right auricle, of the "coronary

[1] Journal of Anat. and Phys., vol. i.; and Proc. Royal Soc. London, 1868.

[2] *Vide* Cunningham, Spinal Nervous System of Porpoise and Dolphin, Journal of Anatomy and Physiology, vol. xi.

vein."[1] It appears to me that only one of these features can be considered as being a universal distinction in the Marsupial heart, and that is the total absence of any land-mark pointing back the early communication which exists between the auricles. In *Thylacine* and *Dasyure*[2] there is not the slightest approach or tendency to a cleavage or bifurcation of the appendix of the right auricle, and in all the animals I examined the great cardiac vein (*i.e.*, the vein which in the human heart expands into the coronary sinus) entered the right auricle by an independent opening placed in the upper part of the auricle by the side of the orifice of the right anterior vena cava.

In *Thylacinus* (Pl. IX. fig. 1) the heart is narrow, elongated and pointed. The *right auricle* is very capacious, and its appendix, whilst it shows no indication of bifurcation, is peculiar on account of its great breadth. On opening into the cavity of this auricle we notice that the walls of the appendix alone present musculi pectinati. The walls of the atrium are perfectly smooth and even. In addition to the minute apertures of the venæ Thebesii, and the small mouths of a few anterior cardiac veins which open directly into the auricle, there are four large venous openings—two in front, and two behind. Those in front are the orifice of the right anterior vena cava (which has the same position as that of the superior vena cava in man), and the orifice of the great cardiac vein which lies at a slightly lower level, and to its inner side. The latter presents a gaping mouth towards the cavity, and both are totally destitute of valves. The two posterior openings are (1) that of the posterior vena cana which has the usual situation, and (2) the opening of the left anterior vena cava which is placed between the orifice of the posterior vena cava, and the auriculo-ventricular opening,—it occupies, therefore, the same position as the coronary aperture in the human heart. The auriculo-ventricular opening readily allows two fingers to be passed through it into the cavity of the right ventricle.

Right ventricle.—The cavity of the right ventricle falls short of the apex of the heart by fully an inch and a half. The conus arteriosus is very pronounced. In the interior of the ventricle the columnæ carneæ are scarce and are altogether absent in the conus arteriosus, and at the apex of the cavity. The musculi papillares are disposed in two groups, viz., one upon the septum near its anterior margin, and the other upon the anterior wall of the ventricle near the right sharp margin of the heart. In connection with each there is a moderator band. That passing from the base of the septal muscle to the anterior wall is very delicate, whilst the other, which stretches between the base of the anterior muscle and the septum, is remarkably strong. Indeed, we might look upon the anterior musculus papillaris as arising by two equal parts, one from the septum, and the other from the anterior wall.

[1] Notes on the Anatomy of the Wombat (Proc. Zool. Soc. 1836, p. 51); Comparative Anatomy and Physiology of Vertebrates, vol. iii. p. 517; Cyclopædia of Anatomy and Physiology (Marsupialia), vol. iii. p. 306.

[2] In his paper upon *Dasyurus macrurus* (Proc. Zool. Soc., 1835, p. 8) he makes no reference to a bifurcated condition of the right auricle. He only says—"The right auricle rose high above the left. Both auricles had smooth short appendices."

The right auriculo-ventricular opening is guarded by a valve formed of five triangular membranous cusps. Three of these lie anteriorly against the anterior wall; one lies to the right in relation to the sharp margin of the heart; whilst the fifth is placed posteriorly against the septum. United at their bases, the five segments constitute an annular membrane by which they are attached around the opening. The three anterior cusps are very small and of equal size; the posterior segment is very large; whilst the right segment is intermediate in size.

The orifice of the pulmonary artery is guarded by the usual three semi-lunar valves.

Left auricle.—The appendix of the left auricle is filled by a very beautiful arrangement of musculi pectinati. These intersect one another, and pass between the walls so closely that the cavity is broken up into a sponge-like texture. There are no musculi pectinati on the walls of the atrium. On the posterior wall there are three venous openings.

Left ventricle.—The cavity of the left ventricle is very narrow and of a conical shape. The fleshy columns are very strongly marked, some, indeed, stretching as thick prominent ridges from the ariculo-ventricular orifice to the apex. The musculi papillares are two in number, and very powerful. The auriculo-ventricular valve is bicuspid, and the segments are placed obliquely as in Man. The orifice of the aorta is provided with the usual three semilunar segments.

Turning now to the *Dasyurus viverrinus* we find that the right auricle of the heart is in every respect the same as in the *Thylacine*. There is no bifurcation of its appendix, and its interior presents the same appearance.

In the right ventricle what strikes one most is the extreme smoothness of its walls. There is hardly a trace of columnæ carneæ except where the septum joins the anterior wall; here we notice a series of "moderator bands" passing from the septum to the anterior wall of the ventricle. The musculi papillares are three in number, and they all spring from the septum. The right auriculo-ventricular valve is peculiar. In front and at the sides of the orifice there is simply a membranous curtain of uniform length hanging down into the cavity, and to this all the chordæ tendineæ from the three musculi papillares are attached. Behind, there is a broad separate segment which is bound directly to the septum by chordæ tendineæ.

The left side of the heart in the *Dasyure* is the same as in *Thylacine*.

In *Cuscus* the heart has the same elongated narrow appearance as in *Thylacinus*. The right auricular appendage, however, presents a deep crescentic notch on its inner free margin into which is received the first part of the aortic arch. So deep is this notch that the aorta is almost completely surrounded by the appendix, and the posterior or upper cornu appears in the internal between the pulmonary artery and the aorta. The left auricular appendage shows no notching, and stretches inwards for a considerable distance in front of the conus arteriosus and the pulmonary artery in the form of a narrow tongue-like process.

Right auricle.—The cavity of the right auricle presents the same characters as those noticed in *Thylacine* and *Dasyure*. The opening of the great cardiac vein, however, is very difficult to find, as it is hidden by musculi pectinati.

Right ventricle.—The cavity of the right ventricle shows several points of difference. The columnæ carneæ are confined almost entirely to the anterior wall. The musculi papillares are two in number, and both spring from the septum. They are long and slender, and one is situated near the anterior interventricular furrow, whilst the other takes origin close to the right sharp margin of the heart. A complete chain of "moderator bands" extends downwards from the conus anteriosus to the apex of the cavity, and binds the anterior wall firmly to the septum. Those which are highest are so large that they even exceed in size the musculi papillares, but they gradually diminish as they are traced downwards to the apex.

The right auriculo-ventricular valve presents four separate membranous segments. These cusps are arranged so that two are placed anteriorly, one to the right, and the fourth, much larger than the others, posteriorly against the septum. The first three of these are connected by chordæ tendineæ, with the musculi papillares; the large posterior cusp is bound down by short, strong tendinous cords which take origin from the septum. It therefore possesses a very limited range of movement.

Left auricle.—The cavity of the left auricle differs from that in *Thylacine*, in having its appendicular walls smooth except towards its free margin, where it shows the reticular arrangement of musculi pectinati.

Left ventricle.—In the left ventricle, the columnæ carneæ are something marvellous in their intricacy and delicacy.

The heart of the *Vulpine phalanger* closely resembles that of the *Cuscus*. The notching of the right auricular appendage is quite as strongly marked, and the only points of difference are found in the right ventricle. Here there are four musculi papillares, all of which spring from the septum and all of which are connected with the three small cusps of the right auriculo-ventricular opening. The large posterior cusp, as in *Cuscus*, is bound directly by chordæ tendineæ to the septum. Further, the moderator bands are neither so distinct nor so numerous.

In the *Phascogale* we note the following points:—(1) the right auricular appendage shows a slight trace of notching, but this has no relation to the root of the aorta; (2) a slight notching of the left auricular appendage is also observable; (3) the musculi papillares are two in number in the right ventricle, and both arise from the septum.

It would appear, therefore, that the distinguishing features of the marsupial heart are two in number, viz.—(1) the absence of all trace of an annulus ovalis and a fossa ovalis, and (2) the peculiar position in the right auricle of the orifice of the great cardiac vein. The notching of the right auricular appendix cannot be regarded as a universal distinction, but when it is present it is a feature of great prominence. It is very clearly figured

by Professor Owen, in his great work upon Comparative Anatomy, in the heart of the Kangaroo and of the Wombat (p. 518, figs. 401 and 402, *a.a*).

Aorta.

In all the animals examined, the aorta describes a very perfect and uniform curve over the root of the left lung. It reaches the spine opposite the lower border of the fourth dorsal vertebra, and then turns backwards.

Except in the case of the *Thylacine* and *Phascogale*, the other animals differ considerably in the manner in which the great vessels arise from the summit of the aortic arch. They all agree, however, in so far that the left subclavian artery has a separate and independent origin from the aortic arch before it turns upwards and backwards to

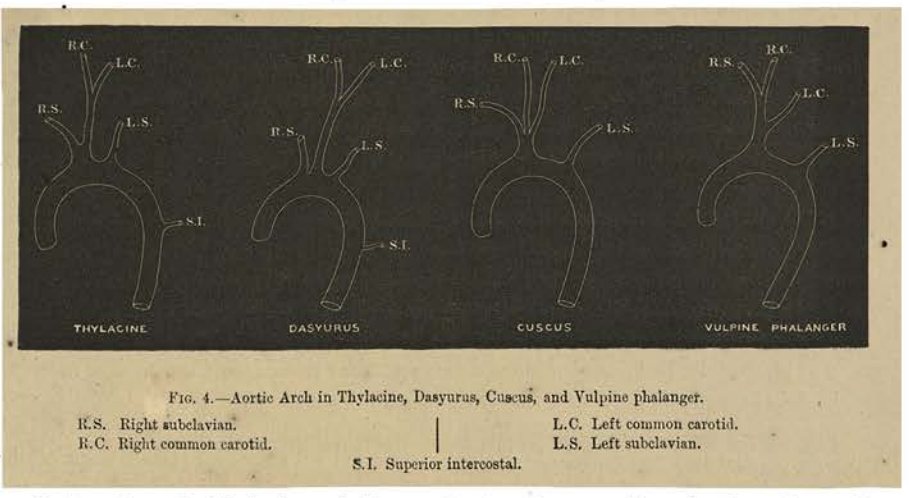


FIG. 4.—Aortic Arch in Thylacine, Dasyurus, Cuscus, and Vulpine phalanger.

R.S. Right subclavian. | L.C. Left common carotid.
R.C. Right common carotid. | L.S. Left subclavian.
S.I. Superior intercostal.

reach the spine. In *Thylacine* and *Phascogale*, the other vessels spring by a short wide trunk from the arch. This very soon gives off the right subclavian artery, and then, continuing forwards for some distance upon the trachea, it finally divides into the two common carotid arteries. In the *Dasyure* the two subclavian arteries come off separately and between them a trunk takes origin, which, after passing forwards upon the trachea for nearly an inch, divides into the two carotids. In the *Dasyurus macrurus*, the great vessels of the aortic arch come off in the same manner as in the *Thylacine*.[1] In the *Cuscus* two vessels proceed from the summit of the aortic arch, viz., the left subclavian and a short wide trunk which very soon breaks up into the two common carotids and the right subclavian. In the *Vulpine phalanger* the same primary vessels

[1] Professor Owen, Notes of a Dissection of a Long-tailed *Dasyurus*, Proc. Zool. Soc., 1835, p. 7.

take origin, but the short wide trunk divides differently; it first gives off the left common carotid artery, and then proceeding onwards for a short distance, divides (like the innominate in man) into a right subclavian, and a right common carotid.

Considerable variation, therefore, is exhibited by Marsupials in the mode of origin of the carotid and right subclavian trunks. The separate origin of the left subclavian is almost universal throughout the group. Mr. Forbes, Prosector to the Zoological Gardens in London, mentions one member of the order (viz., *Belideus breviceps*[1]) in which all the vessels arise from one common trunk or anterior aorta.

The coronary arteries in all the specimens were two in number, and in all the left was much larger than the right. Their openings in the aorta were distinctly above the level of the free margins of the valve segments.

In the *Thylacine* and *Dasyure* the superior intercostal artery of each side springs directly from the aorta at the point where it first touches the spine. This vessel lies in series with the other intercostal arteries, but differs from them in being about three times as large. It runs forwards, and after supplying twigs to the three anterior intercostal spaces it disappears by passing upwards to the dorsal region between necks of the third and fourth ribs. Gaining the superior aspect of the vertebral column, it proceeds forwards between the splenius and semi-spinalis muscles. It can be traced as far as the occipital region.[2]

Pulmonary artery.

The only point to be noted in connection with this vessel is that in none of the animals examined by me was there the slightest vestige of an obliterated ductus arteriosus to be discovered.

Great veins of the heart.

As usual in Marsupials each animal possesses three great caval veins, viz.—(1) a right anterior vena cava, (2) a left anterior vena cava, and (3) a posterior vena cava.[3]

The right anterior vena cava has the same position, relations, and manner of ending as the superior vena cava in man. It pierces the pericardium on the inferior aspect of the root of the right lung and opens into the anterior part of the right auricle.

The left anterior vena cava retains its embryonic course and, piercing the pericardium on the inferior aspect of the root of the left lung, it turns to the right, on the posterior aspect of the heart, in the auriculo-ventricular groove. Here it occupies the same position

[1] Mr. W. A. Forbes, on the Koala, Proc. Zool. Soc., January 1881, p. 189.

[2] In Professor Owen's celebrated article on the Marsupialia in the Cyclopædia of Anatomy and Physiology, the author states that the brachial artery in *Thylacinus* passes over the internal condyle of the humerus, impressing it with a more or less deep groove. In both of my specimens the artery along with its accompanying veins passed through the supra-condyloid foramen.

[3] In the *Belideus breviceps* there appears to be only one anterior vena cava. *Vide* Mr. Forbes' paper on the Koala, Proc. Zool. Soc., 1881, p. 188.

as the coronary sinus of man, and, like it, opens into the posterior part of the right auricle close to the orifice of the posterior vena cava. Towards its termination it is covered by a thin stratum of muscular fibres derived from the muscular wall of the heart.

The posterior vena cava has the usual mode of termination.

The pulmonary veins are two in number on each side.

Veins of the thoracic parietes.

In the *Thylacine* the vena azygos runs forward upon the right side of the vertebral column, and drains the blood from all the intercostal spaces, with the exception of the anterior three upon both sides. It ends by hooking downwards above the root of the right lung, and joining the right anterior vena cava. The three

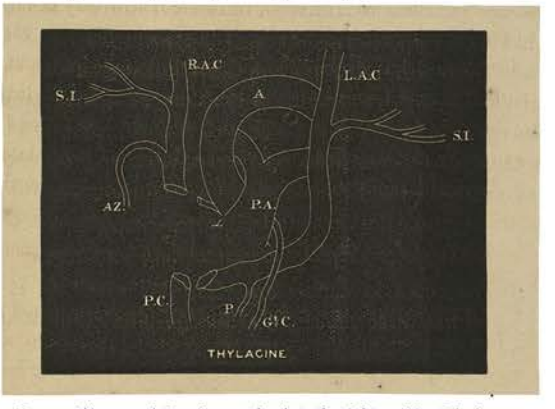


FIG. 5.—Diagram of the veins opening into the right auricle of the heart.

AZ.	Vena azygos major.	G. C.	Great cardiac vein.
S.I.	Superior intercostal (right).	P.	Posterior cardiac vein.
R.A.C.	Right anterior vena cava.	P.C.	Posterior vena cava.
L.A.C.	Left anterior vena cava.	A.	Aorta.
S.I.	Superior intercostal vein (left).	P.A.	Pulmonary artery.

anterior intercostal veins of the right side join to form one trunk, which pours its blood into the right anterior vena cava whilst the corresponding veins of the opposite side likewise unite to open into the left anterior vena cava.

In the *Cuscus*, *Dasyure*, *Vulpine phalanger*, and *Phascogale* there is also a single azygos vein; this, however, runs forward upon the left side of the spine. It receives all the blood from the intercostal spaces of its own side, and all the intercostal veins of the right side with the exception of the anterior three. It hooks over the root of the left lung, and joins the left anterior vena cava. The anterior three intercostal veins of the right side unite to pour their blood into the right anterior vena cava.

Cardiac veins.

The cardiac veins were very carefully followed out in the heart of the *Thylacine*. An opening was made into the larger veins, and then the whole cardiac venous system was inflated by a blow-pipe. In this way the vessels could be traced with great precision.

The cardiac veins may be divided into an anterior and a posterior group.

The posterior cardiac veins open into the left anterior vena cava as it lies in the groove between the left auricle and left ventricle. One of these veins is much larger than the others. It begins at the apex (usually upon the anterior surface) and ascends in the posterior interventricular furrow to join the left caval vein close to its termination.

The anterior cardiac veins consist of—(1) some small twigs ascending upon the anterior surface of the right ventricle to open independently into the right auricle, and (2) the great cardiac vein—a vein which is always so conspicuous in the Mammalian heart.

The great cardiac vein takes origin near the apex of the heart. It ascends in the anterior interventricular furrow, and receives numerous tributaries, so that when it reaches the auriculo-ventricular groove it has attained a very considerable magnitude. So far its course agrees with that seen in other Mammals; now, however, instead of winding round the left margin of the heart to join the left anterior vena cava, it deviates to the right, passes behind the pulmonary artery and the aorta, and opens into the upper part of the right auricle, close to the entrance of the right anterior vena cava (Fig. 5). As it lies behind the aorta and pulmonary artery it expands somewhat, and some of the muscular fibres of the heart are thrown over it.[1]

Owing to the small size of the heart in the other animals examined these points could not be made out with the same precision. In all, however, no cardiac veins joined the left anterior vena cava except those from the posterior surface of the heart; in all a small venous opening was noticed in the right auricle close to that of the right anterior vena cava; and in the *Dasyure* and *Cuscus* a fine probe introduced into this passed along a venous channel which lay behind the aorta and pulmonary artery. From these facts I conclude that they all present the same arrangement of cardiac veins.

Owen, in the third volume of his work upon Comparative Anatomy and Physiology, states that "the opening of the left precaval is close to that of the postcaval, in a position analogous to that of the coronary vein in man, which here opens into the left precaval." The coronary vein which he thus refers to is, no doubt, the large posterior cardiac vein which ascends in the posterior interventricular furrow. I cannot, however, understand a remark made by Mr. Forbes[2] in his paper upon the Visceral Anatomy of the Koala, viz., that "there is apparently only a single opening for the coronary veins, just at the entrance of the inferior cava into the auricle." Writing upon the same animal

[1] It is interesting to note that at the point where this vein opens into the right auricle there is almost invariably in the human heart the minute orifice of a vein of Thebesius.

[2] Proc. Zool. Soc., 1881.

Mr. Martin states that "six coronary veins entered the right auricle round its junctional margin with the ventricle."[1] These were undoubtedly the small cardiac veins which ascend upon the anterior wall of the right ventricle.

Mr. Marshall[2] in his memoir upon the development of the great anterior veins divides mammals into groups, according to the manner in which these veins are arranged. In the first group, which consists of those animals in which the right and left anterior venæ cavæ persist, and in which the great coronary and other veins in its course join the left anterior vena cava, he places the Marsupials. If, however, the arrangement of the coronary veins, which was so evident in the *Thylacine* is general through Marsupialia, they cannot be included in this group; indeed, they represent a mode of termination of the great cardiac vein, which, so far as I am aware, has not been noticed in any other mammal.

Trachea and Lungs.

Trachea.—The following is the length of the trachea as it was exhibited in each marsupial examined :—

Thylacine,	6¾ inches,	34 cartilaginous rings.
Cuscus,	3 „	26 „
Dasyure,	2 „	25 „
Vulpine phalanger,	2¼ „	29 „
Phascogale,	1 „	21 „

In the *Thylacine*, *Cuscus*, *Dasyure*, and *Phascogale* the tracheal rings were deficient superiorly throughout the entire length of the tube; in the *Vulpine phalanger* they constituted complete rings round the tube in the anterior half of the windpipe; behind this they were deficient above.

Lungs.—In the *Thylacine* and *Dasyure* the left lung is undivided by any marked fissure, in the former, however, the margin is deeply crenated, whereas in the latter it is uniform. In the *Cuscus*, *Phascogale*, and *Vulpine phalanger* the left lung is partially divided into two lobes of nearly equal bulk by a fissure which extends upwards from the lower sharp margin.

In each case the right lung is furnished with a well-marked pyramidal azygos lobe which is separated from the right lung by the posterior vena cava, and rests by its base upon the upper surface of the diaphragm.

In all the animals examined the right lung is divided into three lobes. This subdivision, however, is not nearly so well marked in the *Thylacine* as in the others.

Abdominal Viscera.

Thylacine.

Stomach.—The distended stomach of the *Thylacine* has a close resemblance to that

[1] Proc. Zool. Soc., 1836.

[2] Phil. Trans., vol. cl., 1850, p. 150.

of Man. The curvatures, however, are more pronounced, and the transition from the wide cardiac portion to the narrow pyloric part more sudden. The fundus rises high above the cardiac opening. The following are the measurements of the stomach of the small female specimen: –

	Inches.
Length of the lesser curvature (measured from the opening of the œsophagus to the pylorus),	4
Length of the greater curvature (measured from the cardiac orifice over the high fundus to the pylorus),	19
Girth of the organ at the cardiac orifice,	12½

On turning the stomach outside in, the lining mucous membrane is observed to be highly rugose—the rugæ, however, almost entirely disappearing on distension. The mucous membrane does not present the same appearance throughout. At the fundus it is thin and smooth; towards the pylorus it becomes thicker, more pulpy, and marked by numerous irregular depressions which doubtless correspond with the alveoli of the human stomach. When distended to its utmost extent the mucous membrane still shows these alveolar depressions. A marked pyloric constriction separates the stomach from the small intestine.

Intestinal canal.—The intestinal canal proceeds backwards as a uniform tube, and at the pelvis becomes continuous with the rectum. There are no indications by which it can be divided into a small and large intestine. It is remarkably short, and diminishes slightly in calibre as it is traced towards the pelvis The rectal portion, however, expands so as to assume a diameter equal to, or even greater than that of the upper or duodenal part. The following is the length of the canal in the two specimens:—

	Feet.	Inches.
Length of the intestinal canal (Male),	6	5
do. do. (Female),	4	8
Girth when fully distended with spirit (Male)—		
(*a*) Duodenal end,	0	5
(*b*) Immediately above the rectum,	0	4¼

Owen[1] gives the length of the intestinal canal in a *Thylacine* which measured 3 feet 4 inches from snout to vent as 9 feet 8 inches. This is relatively very much longer than in either of the Challenger specimens.

The intestinal villi are remarkable for their great length (Pl. X. figs. 1, 2, 3, and 4). In the anterior part of the tube they are fully half an inch long, and are arranged sparsely over the mucous surface, so that the interior of the gut has a rough shaggy appearance. In the anterior portion of the intestine they are filamentous and

[1] Article "Marsupialia" Cyclopædia of Anat. and Phys., p. 304.

slender, but they gradually become stouter and club-shaped (Pl. X. fig. 1). Proceeding still further back they diminish greatly in numbers, become stunted and conical, and finally arrange themselves in parallel longitudinal rows (Pl. X. figs. 2, 3, and 4). About 16 inches above the anal orifice they disappear.[1]

Plate X. fig. 5 represents a small portion of the intestine of the Lion, inverted to show the villous surface. Comparing this with fig. 1 it will be seen that the character of the villi in the *Thylacine* is altogether different. In the former the mucous surface is fleecy, and in the latter it is shaggy.[2]

Peyer's patches.—One Peyer's patch of enormous extent begins about 16 inches above the anus, and extends forwards for 22½ inches in the male, and 14 inches in the female. It is not placed opposite the mesenteric attachment but coincides with it, and it presents a minutely honey-combed appearance. In connection with this patch the mucous membrane is elevated into a feebly-marked ridge which runs along its whole length, and frequently divides and reunites. Alveolar pits are grouped upon and on either side of this ridge. Figure 3 (Pl. X.) represents the lower end of this patch.

In addition to this large patch there are several others placed further forwards in the gut (viz., three in the male and five in the female). In the male these were from one to two inches long; in the female they were with one exception (viz., that figured in Pl. X. fig. 4) not more than half an inch long. The small Peyer's patches are much obscured by villi, and can only be detected by a careful search.

In the rectum the mucous membrane is perfectly smooth, and is everywhere perforated with the minute orifices of Lieberkühnean glands. These are quite visible to the naked eye.

The intestinal canal is suspended from the upper abdominal wall by a simple mesentery.

Cuscus.

Stomach.—This stomach is smaller than that of the *Vulpine phalanger*. It is pyriform in shape with the pyloric end bent upwards upon itself, and held in position by a strong band which bridges across, and continues the lesser curvature over the constriction. When this band remains uncut the œsophagus joins the stomach at the middle of the lesser curvature; when it is divided and the pyloric end of the stomach freed, the gullet enters much nearer the left than the right extremity of the curvature.

The cardiac cul-de-sac rises high above the cardiac orifice, and the œsophagus traverses the abdomen for fully an inch before it enters the stomach.

[1] The mucous lining of the intestine of the *Dasyurus viverrinus* is provided with extremely small villi, barely visible to the naked eye. They are filamentous in form and are sparsely set. The zone of glands mentioned by Professor Owen (Proc. Zool. Soc., 1835), as being present at the commencement of the duodenum of the *Dasyurus macrurus* is apparently absent in the *Viverrine Dasyure*. It is also absent in *Thylacine*.

[2] The villi of the anterior part of the intestine in Thylacinus are very similar to those in the small intestine of the Rhinoceros. They are quite as long, but are not nearly so thickly set upon the mucous surface.

The stomach has thick muscular walls, and the duodenum is marked off by a deep constriction.

Internally, the mucous membrane is rugose when the organ is flaccid, but the folds disappear upon distention. Along the lesser curvature, and towards the pylorus, the same alveolar depressions which were noticed in the stomach of the *Thylacine* are observed in the stomach of the *Cuscus*. The following are the measurements:—

	Inches.
Length of the greater curvature from the highest point of the cardiac cul-de-sac to the pylorus, . . .	9
Length of the lesser curvature between the same points, . .	2½

Small intestine.—The small intestine measured 5 feet 4 inches in length. The calibre of the gut gradually diminishes as we trace it towards the cæcum. The bile-duct (previously joined by the pancreatic duct) opens into the duodenum at a point 2¼ inches distant from the pyloric constriction.

The mucous membrane of the small intestine is exceedingly thin and delicate in its texture. It is covered by minute villi, which give it the usual velvety appearance.

The Peyer's patches vary greatly in size and shape. The largest was fully one inch long by half an inch broad;—the smallest was a mere speck. They were nine in number. The first was placed about twenty-two inches behind the pylorus; the last was situated five inches in front of the junction of the ileum with the cæcum.

Large intestine.—The large intestine may be divided into a cæcum, colon, and rectum.

The cæcum is very long and capacious. It measured in length 2 feet 9 inches, whilst its girth at its widest part was 5½ inches. From the entrance of the ileum to its extremity, it tapers uniformly and terminates in a blind end which is little larger than the stem of an ordinary tobacco pipe. It shows a slight sacculation along its convexity, opposite the line of mesenteric attachment.

The colon was five feet long. It is very wide where it is continuous with the cæcum, but its calibre diminishes gradually as it is traced towards the rectum, where it assumes a diameter considerably less than that of the small intestine.

Peritoneum.—In the *Cuscus* the great omentum is very short, and composed of the usual four layers of peritoneal membrane. The two inferior of these layers when traced forwards, are observed to enclose the stomach, form the gastro-hepatic omentum, and finally to invest the liver completely and bind it by a distinct fold to the posterior surface of the diaphragm. The two superior layers of the omentum proceed directly upwards to the spine where they separate. The anterior layer is carried forwards upon the upper abdominal wall, whilst the posterior layer leaves the spine to form an extremely voluminous mesentery (6½ inches long) for the colon. From the root of this fold the peritoneum again leaves the spine to form the mesentery of the small intestine which is only three inches long.

In the *Vulpine phalanger*, the mesentery of the great intestine is only four inches long, whilst that of the small intestine is five inches long.

The mesenteric glands are few in number but relatively of large size.

The cæcum has a distinct mesentery which is continued to its extremity, and is an offshoot from the meso-colon.

The duodenum is completely invested by peritoneum, and there is no demarcation of any kind between it and the jejunum.

Spleen.—In both *Thylacine* and *Cuscus* the spleen is an elongated tongue-like organ completely invested by peritoneum, and placed obliquely in the abdominal cavity. From its outer border a process of spleen substance projects towards the kidney. The splenic vessels, nerves, &c. enter the organ upon its inner surface along the line of the mesenteric attachment.

Pancreas.—The pancreas is well developed in both the *Thylacinus* and *Cuscus*. It consists of a thickened massive right extremity or head from which an elongated process of gland substance projects towards the spleen. The pancreatic duct joins the bile duct before it enters the duodenum.

Liver.—In describing the liver we shall adopt the admirable nomenclature suggested ten years ago by Professor Flower[1] in his lectures on the Comparative Anatomy of the Organs of Digestion in the Mammalia. In neither animal is there a trace of the "round ligament." This condition is to be associated with the total absence of a fossa ovalis in the heart, and of the ductus arteriosus.

In the *Cuscus* the liver is divided into a right and a left segment by a deep fissure which may be termed the umbilical cleft. It cuts the organ almost completely into two, and its significance is shown by its coinciding with the line of the suspensory ligament. The left segment, which is only very slightly smaller than the right, is subdivided by a deep cleft (the left lateral fissure of Flower), into a large "left lateral lobe" and a very small "left central lobe." The right segment also consists of a "right central lobe," and a "right lateral lobe." The latter is very small and insignificant, and the fissure (right lateral fissure) which cuts it off is very deep and almost reaches the attached border of the organ. The right central lobe is the largest of all the subdivisions of the liver. Behind it is hollowed out into a deep ditch or furrow which runs in the antero-posterior direction about its middle. This furrow contains the upper end of the gall bladder and the cystic duct, and extends upwards to the portal fissure; traced forwards it widens out and at the same time deepens, and finally it becomes a distinct V-shaped cleft in the sharp free margin of the liver which allows the fundus of the gall-bladder to be seen from the front.

The accessory lobes are both present. The Spigelian lobe is well marked, and is partially sub-divided by shallow clefts into three subsidiary portions. It has a leaf-like

[1] Medical Times and Gazette, vol. i., 1872, p. 292.

form and hangs freely down from the right segment of the liver behind the portal fissure. The caudate lobe is comparatively speaking very small. It is prismatic in form.

The vena cava passes through a complete tunnel of liver substance.

The liver of the *Thylacine* differs very materially from that of the *Cuscus*. The left segment is small in comparison with the right segment, and shows no tendency whatsoever to subdivision into lateral and central lobes. The right segment, however, is divided into two equal portions by a well-marked cleft and the right central lobe shows a deep and broad deficiency in its sharp free margin for the reception of the gall-bladder. The caudate lobe is of great length (fully four inches long), and prismatic in form, whilst the Spigelian lobe is small and attached by a broad base partly to the left segment, and partly to the right segment of the liver.

The vena cava is not covered in by liver substance.

Gall-bladder and bile-ducts.—The gall-bladder in the *Cuscus* is very large and pyriform in shape. It is firmly attached in its upper half to the under surface of the right central lobe, whilst its lower half is free and projects downwards in the cleft in the free margin of this lobe. In the *Thylacine* the gall-bladder is very small and when distended it has a globular shape; in shape and size it is not unlike a large walnut. In both animals the cystic duct emerges from the upper end of the gall-bladder, and runs upwards to the portal fissure. Here it is joined by three or four hepatic ducts which issue from the various lobes, and enter it by separate orifices. The common bile duct is thus formed and before it opens into the duodenum it is joined by the pancreatic duct.

The mucous membrane lining the gall-bladder of the *Cuscus* at first sight appears to be smooth, but on close inspection it is seen to be very finely reticulated. In the *Thylacine* it presents a very strongly marked honey-combed appearance.

Genito-urinary Organs.

I regret that, owing to an unfortunate accident which happened to the pelvic viscera of the female *Thylacine* before they were examined, I am only able to give a detailed account of the genito-urinary apparatus in the male *Thylacine* and male *Cuscus*. The recent and very excellent paper by Dr. Young of Manchester, upon the Male Organs of Generation in the Koala,[1] together with the full details given by Professor Owen in his article on the Marsupialia in the Cyclopædia of Anatomy and Physiology renders this task a comparatively easy one.

Male *Thylacine* (Pl. X. figs. 6 and 7).

Kidneys, ureters, and bladder.—The kidneys present the usual reniform outline. The sinus, however, is very small, and has a very constricted outlet. On section, the

[1] Journal of Anatomy and Physiology, vol. xiii. p. 305.

organ presents a uniform medullary substance coated by a thin layer of cortical substance. The uriniferous tubules open upon the surface of a single prominent papilla which projects into the pelvis of the kidney. The ureters where they are attached to the kidneys show only a very slight expansion.

The bladder (fig. 6, *b.*, and fig. 7, *c.*) was in a contracted state, and was remarkable for its small size; indeed it was not larger than a small walnut. In shape it is ovoid—compressed from before backwards—and its walls are exceedingly thick and muscular. It is completely invested by peritoneum, and connected by a distinct fold or mesentery to the upper aspect of the lower abdominal wall. No trace of a urachus could be detected. In front the muscular fibres are disposed in strongly-marked transverse columns which are separated from each other by intervening fissures; laterally, they have a longitudinal direction, whilst behind, they run in the form of oblique bundles with furrows between them. The neck of the bladder abuts against the broad anterior end of the prostate, and its walls are much thinner than those of the body of the viscus.

The ureters (fig. 6, *a*) pierce the inner aspect of the neck of the bladder, one on each side of the mesial plane and about a quarter of an inch apart. Immediately behind these the vasa deferentia (fig. 6, *c*) pierce the commencement of the urethra.

The mucous membrane lining the bladder in its contracted state is very rugose, more especially towards the summit. Near the neck of the organ the rugosity becomes less marked, and where the neck merges into the urethra it is perfectly smooth.

The ureters pursue a curious course through the vesical wall; at first directed backwards for a distance of about a quarter of an inch they then bend suddenly forwards and increase in calibre. Each duct opens upon a prominent papilla situated at the neck of the bladder.

Testicles and vasa deferentia.—The body of the testicle is small and spherical, not more than half an inch in diameter. The epididymis on the other hand is exceedingly large, and so long that it surrounds the body of the testicle for fully three-fourths of its circumference. The vas deferens is a slender uniform tube—$7\frac{1}{4}$ inches in length. It shows no tendency to dilatation or sacculation as it approaches the neck of the bladder, and it has no diverticulum or seminal vesicle in connection with it. It sinks into the urethral wall, close to the base of the prostate, and immediately behind the point where the ureter disappears into the vesical wall.

Prostate, (fig. 6, *m*, fig. 7, *d*). The prostate is a large pyriform body, possessing a shape very similar to that of a carrot. It commences at the neck of the bladder by a broad base, and it gradually tapers away as it is traced towards the outlet of the pelvis until it is finally lost upon the urethra. In length it measured four and a half inches, whilst its base or broadest part had a diameter of three quarters of an inch. The urethra traverses its entire length and its surface is smooth and uniform, with no external marking or furrow of any kind indicative of a lobular constitution.

Prostatic portion of the urethra (fig. 7).—For about an inch and a half from its commencement, the urethra is widely dilated and fusiform in outline. From this onwards it presents a uniform calibre. The vasa deferentia, which pierce the urethral wall very obliquely, open upon the floor of this portion of the canal by two slit-like openings (fig. 7, *b*) placed close together, and about a quarter of an inch from the neck of the bladder. Up to this point the mucous lining of the tube is perfectly smooth, but immediately beyond, it is raised into a series of delicate and faintly marked longitudinal ridges which extend along the whole length of this part of the urethra. In the intervals between these ridges the prostatic ducts open in rows. These are quite visible to the naked eye, and on subjecting the prostate to pressure a small quantity of a brownish viscid fluid is observed to ooze out through the minute orifices.

There is not the slightest trace of a veru-montanal eminence in the *Thylacine;* nor is there any indication of a sinus pocularis.

Cowper's glands (fig. 6, *h* and h^2). These are four in number, two being placed upon either side of the mesial plane, the one in front of the other. The anterior gland on each side is about the size of a pigeon's egg, and it has a reniform shape; the posterior gland is about half the size of the other and overlaps it slightly. A long slender duct emerges from the centre of each and the four ducts thus derived all enter the urethra at the point where it sinks into the erectile tissue of the corpus spongiosum. But further, each of these glandular bodies is enveloped by a complete and thick capsule of muscular fibres which is continued for a short distance upon the duct. Small fleshy slips connect these capsules with the levator penis muscle of the same side.

Penis (fig. 6).—The body of the penis measured, from the junction of the crura to the extremity of the glans, six inches. It consists of the usual constituents, viz., two corpora cavernosa, and a corpus spongiosum. At the extremity of the organ the corpus spongiosum is split into two so as to form a forked glans penis.

Posteriorly the corpora cavernosa separate widely from each other to form the crura (fig. 6, *f.* and *f.g.*). Each crus ends in a blunt rounded point, and is enveloped in a thick layer of muscular fibres. In length it is about two inches, and is firmly fixed to the margin of the pubic arch in its middle third. The posterior end is therefore free, and surrounded as it is by a muscular capsule it appears at first sight to belong to the Cowperian glands with which it lies in series.

The bulb of the penis, as is usual in Marsupials, is split mesially into two equal portions (fig. 6, *i*). These are rounded in form and are about the size of an ordinary marble. Each half is continuous by means of a broad pedicle with the erectile tissue of the corpus spongiosum of the body of the penis and each is covered by a thick capsule of muscular fibres which apparently take origin from the aponeurosis investing the pedicle.

Muscles of the Penis.—The penis is supplied with four pairs of muscles, viz.:—

1. Retractores penis (fig. 6, *k*).
2. Levatores penis (fig. 6, *e*).
3. Bulbo-cavernosi (fig. 6, *i*).
4. Ischio-cavernosi (fig. 6, *g*).

The retractores penis are two long narrow muscular bands which arise from the under surface of the sacrum and run side by side along the upper surface of the penis to the base of the forked glans where they are inserted.

The levator penis of each side springs from the inner aspect of the tuber ischii internal to the attachment of the crus penis. Passing backwards between the two crura it is inserted upon the inferior surface of the penis at the point where the crura join.

From the levatores penis fleshy slips are given off to the muscular capsules which envelope Cowper's glands. Thus two slips join the capsule of each of the anterior glands whilst one slip proceeds to the capsule of each of the posterior glands.

The bulbo-cavernosi constitute two thick and powerful muscular envelopes for the two halves of the bulb of the corpus spongiosum. In each case the fibres arise from a strong aponeurosis upon the corresponding crus penis.

The ischio-cavernosi or erectores penis enclose the crura penis. The fleshy fibres arise from the ischial tuberosity and constitute a remarkably thick covering for the crura. In Plate X. fig. 6, the erector penis of the left side (*g.f*) is represented undisturbed; on the right side, it (*g*) has been slit open so as to expose the crus.

Cuscus (Pl. X. figs. 8, 9, 10, and 11).

Kidneys, ureter, and bladder (fig. 8).—The Kidneys (*a*) differ from the same organs in *Thylacine* only in point of size. Each measured one inch in length and about three quarters of an inch in breadth. The ureters (*c*) were six inches long. They open into the bladder about a quarter of an inch apart from each other and about the same distant from the neck of the viscus.

The bladder (*m*) when distended has a size similar to that of a small hen's egg. It is uniformly oval in form—its fundus and base presenting equal proportions. The neck of the bladder is embraced by the prostate and is pierced by the vasa deferentia immediately behind the openings of the ureters.

Testicles and vasa deferentia (fig. 8).—As in *Thylacine* each testicle consists of a small body surrounded by a very large epididymis. The body (*d*) is smooth and oval and about the size of a haricot bean. The epididymis (*e*) is crescentic in form and folded round the body of the testicle, but only structurally connected with it by its upper end or globus major; below this the epididymis is held in position by a loose fold of the visceral portion of the tunica vaginalis which stretches between it and the body.

Prostate (fig. 8, *k*).—The prostate gland presents the same shape as in *Thylacine*. In length it measures fully one inch, whilst its diameter at its broadest part or base is about a quarter of an inch. Its anterior end or base embraces the neck of the bladder whilst its narrow posterior end is gradually lost upon the urethra.

Prostatic portion of the urethra (fig. 10, *c*).—The prostatic urethra is wide at its commencement, but gradually diminishes in calibre as it is traced through the gland. Its mucous lining is smooth throughout its whole length. It shows only a very slight indication of the ridges which are so very evident in the *Thylacine*, and the orifices of prostatic ducts are barely visible to the naked eye. The vasa deferentia open by two minute apertures immediately beyond the neck of the bladder and there is no trace of a veru-montanal eminence, or of a sinus pocularis.

The sinus pocularis is absent in the great majority of marsupials. The disappearance of all structures pointing back to the embryonic condition may be considered one of the distinguishing features of the order. It is therefore a fact of the greatest interest to find "an ill-defined utriculus or sinus pocularis" in the Koala.[1]

Cowper's glands (Pl. X. fig. 8, *g*, and fig. 9, *b*).—These are two in number. They are placed in the interval between the two divergent crura—one upon either side of the membranous portion of the urethra. In size they are not larger than peas, and each is provided with a distinct muscular capsule and has a narrow duct proceeding from it. This duct after a course of about a quarter of an inch pierces the urethral wall and opens into the commencement of the spongy portion of the urethra.

In the *Vulpine phalanger* the corresponding glands are four in number as in *Thylacine*, but they are exceedingly minute.

Penis.—The length of the penis from the junction of the different parts of the root to the extremity of the forked glans was 1½ inches. The body of the organ is composed of the usual three constituents. The glans is long and forked and measured almost half an inch in length; the root of the penis has no direct attachment to the outlet of the pelvis.

The crura penis (fig. 8, *f*, and fig. 9, *c*) are remarkably long, having a length almost equal to that of the body of the penis. They are bulbous at their extremities, and widely divergent. The bulbous free end is clothed by a thick muscular capsule—the erector penis—but this is at no point attached to the pelvic bone. The narrower posterior portion of the crus is naked.

The bulb (fig. 8, *h*, and fig. 9, *d*) is double. Each half lies upon the upper surface of the uncovered portion of the corresponding crus, and is enveloped in a thick fleshy capsule—the bulbo-cavernosus. The two portions of the bulb unite to form the corpus spongiosum into which the membranous portion of the uretha sinks.

Muscles of the penis.—These are the same as in *Thylacinus*. The retractores penis

[1] Young, Jour. Anat. and Phys., vol. xiii. p. 309.

(fig. 8, *l*) and the bulbo-cavernosi (fig. 8, *h*) are identical in every respect, whilst the ischio-cavernosi (fig. 8, *f*) differ in having no pelvic attachment.

The levatores penis (fig. 8, *i*, and fig. 9, *e*) lie upon the under surface of the organ. Each muscle springs from the corresponding crus and inclines towards the mesial plane, where it joins its fellow of the opposite side to form a narrow tendon. This is continued onwards to be inserted into the base of the glans.

Anal glands (fig. 11, *b*, b^2, b^3).—These glands may be conveniently noticed here. They are six in number. Three are situated upon either side of the common opening into which they open by long independent ducts. Each gland has a muscular capsule, and consists of a single large chamber which, in the specimen examined, was filled with a brown curdy secretion. The largest of the series was about the size of a marble, whilst the smallest was as large as a haricot bean.

In the *Vulpine phalanger* the same number of anal glands is present, but they are much smaller in size. In the *Thylacine* they are absent.

Sphincter cloacæ.—This muscle presents the same connections in both *Thylacinus* and *Cuscus*. It forms a complete sheath for the anus and the numerous glands, and parts in connection with the root of the penis. The glands, &c., are packed within it, in the midst of soft fat. Above the common opening it is present in the form of a strong narrow muscular bundle. As this is traced forwards, it is observed to expand, so that on the inferior aspect of the opening it constitutes an exceedingly thin muscular web—so thin, indeed, that the structures it encloses shine through it. In front, this thin sheet of fibres has a distinct attachment on either side to the crus of the penis; behind its fibres are inserted into the skin surrounding the mouth of the common opening. It has no attachment to bone.

Marsupium of the Female *Thylacine*.

The marsupium of the female *Thylacine* which I examined, is figured in Plate IV. (fig. 3). It was evidently a very young specimen. This was manifest not only by its small size but also by the immature condition of its bones. I am inclined to believe that it had never borne young.

The marsupium was oval in form and exceedingly shallow. Its long axis, which was directed from before backwards, measured two inches, whilst its transverse diameter was one and a half inches. In front and behind there was little or no demarcation between the pouch and the surrounding skin of the abdomen. Laterally, however, it was well mapped out by prominent overhanging folds of integument. The skin forming these folds and the floor of the marsupium, was of a very delicate texture and slightly wrinkled. With the exception of some sparse white downy hair it was quite bare. At the limits of the pouch this downy hair was suddenly replaced by the ordinary hairy coat of the animal.

On the floor of the pouch there were four small conical elevations. These were very slightly raised above the general surface, and were situated in the centre of the pouch. On the summit of each elevation there was a minute aperture barely visible to the naked eye, and on applying a magnifying glass and separating the lips of the opening with a needle an exceeding minute teat was observed within. The conical elevations, therefore, simply represented the integumental sheaths of the teats.

In the description of the mammary organs of a Kangaroo by Mr. Morgan (Trans. Linnean Soc., 1826), it is stated that the teats "after once being developed by protrusion from their original situation in the substance of the gland, never again recede to their former condition, but constitute permanent marsupial teats throughout the rest of life." This statement confirms me in my opinion that the female *Thylacine* was in a virgin condition.

Sphincter marsupii (Pl. IV. fig. 4, *s.*). Reflecting the skin from the pouch a powerful sphincter muscle is exposed. It is simply a portion of the panniculus carnosus. In front the fibres decussate, whilst behind the two bands meet, and are inserted into the fibrous tissue in front of the symphysis pubis. The inner margin of the muscle is contained in the fold of integument bounding the pouch laterally, and is round and thick. Externally, the fleshy fibres blend with those of the panniculus carnosus.

Mammary glands.—The mammary glands could not be detected as structures distinct from the superficial fascia in which they are placed. Within the area, surrounded by the sphincter marsupii, several large lymphatic glands are embedded in the superficial fascia at the back part of the pouch (fig. 4, *l.g.*).

Cremaster muscle[1] (fig. 4, *c.*). This is a strongly-marked muscular band which arises by two slips (1) from the anterior superior iliac spine, and (2) from the posterior border of the transversalis muscle. Emerging from under cover of the internal oblique, it passes downwards and inwards under cover of the aponeurosis of the external oblique. It finally appears through the external abdominal ring, and passing under cover of the sphincter marsupii, spreads out under the two nipples of its own side. It was impossible to make out its precise connection with the teats. In the mammary region a large branch of the deep epigastric artery is distributed, and a large nerve, the genito-crural (fig. 4, *g.c.n.*) enters the substance of the cremaster muscle.

[1] In the male the cremaster muscle has the same origin. It envelopes the vas deferens, and spreads out upon the tunica vaginalis.

EXPLANATION OF THE PLATES.

PLATE I.—Fore Limb of *THYLACINUS CYNOCEPHALUS*.

Fig. 1. Right manus—palmar aspect—dissection of the intrinsic muscles.
Fig. 2. Right manus—dorsal aspect.
Fig. 3. Left manus—palmar aspect—adductors reflected.

Palmar layer.
- *a.* Adductor indicis.
- *b.* Adductor annularis.
- *c.* Adductor minimi digiti.
- *a.b.* Common origin of adductores annularis et indicis.
- c^1. Insertion of adductor minimi digiti.

Intermediate layer.
- g^1. Flexor brevis pollicis.
- g^2. Flexor brevis indicis.
- g^3. Flexor brevis medii.
- g^4. Flexor brevis annularis.
- g^5. Flexor brevis minimi digiti.

Dorsal layer.
- *e.* Abductor pollicis.
- d^1. First dorsal interosseus.
- d^2. Second dorsal interosseus. } Observe the double insertions
- d^3. Third dorsal interosseus. } of these two muscles.
- d^4. Fourth dorsal interosseus.
- *d.* Abductor minimi digiti.
- f^1. and f^2. Two accessory slips, probably additional parts of the abductor minimi digiti.
- *h.* Accessory abductor annularis.

Fig. 4. Muscles of the shoulder—right fore limb of the male Thylacine.
c.m. Cleido-mastoid.
cl. Rudimentary clavicle.

Fig. 4. *tr.* Trapezius.
c.d. Clavicular deltoid.
c.h. Cephalo-humeral.
p.m. Pectoralis major.
b. Biceps.
tr^2. Outer head of triceps.
b.a. Brachialis anticus (drawn backwards by a hook).
tr^1. Long or middle head of triceps.
$t.m^1$. Teres major.
i.s. Infra-spinatus.
s.s. Supra-spinatus.
s.d. Scapular deltoid.
ac. Acromion process.
$t.m^2$. Teres minor.

Fig. 5. Left fore limb of the male Thylacine.
s.c. Subclavius.
ac. Acromion process.
s.s. Supra-spinatus.
a.t. Acromio-trachelic
tr. Trapezius.
i.s. Infra-spinatus.
s.d. Scapular deltoid.
$t.m^1$. Teres major.
tr^1. Long or middle head of triceps.
tr^2. Outer head of triceps.
d.e. Extensor secundi internodii pollicis.
r.l. Extensor digitorum secundus.
m.u. and *c.u.* Extensor carpi ulnaris, split up into two distinct muscles.
an.l. Posterior annular ligament.
m.r. and *c.r.* Extensor ossis metacarpi pollicis, split up into two portions.
c.d. Extensor communis digitorum.
c.b. Extensor carpi radialis brevior.
c.l. Extensor carpi radialis longior.
s.l. Supinator longus.
b.a. Brachialis anticus.
b. Biceps.
c. Circumflex nerve (cutaneous branch).
p.m. Pectoralis major.
c.h. Cephalo-humeral.

Fig. 5. *tr.* Trapezius.

Fig. 6. Diagram of the brachial plexus of the Thylacine.

C.V. to C.VIII. The posterior four anterior primary divisions of the cervical spinal nerves.

D.I. The anterior primary division of the first dorsal nerve.

a. Branch which connects the fourth and fifth cervical nerves.

b and *c.* Twigs to the skin of the neck and the outer and dorsal aspects of the shoulder.

s.c. Nerve to the subclavius.

s. Suprascapular nerve.

s.s. Subscapular nerves.

p.c. Branch to the panniculus carnosus.

c.f. Circumflex nerve.

m.c. Musculo-cutaneous, which comes off in two distinct parts.

m.s. Musculo-spiral.

m. Median nerve.

u. Ulnar nerve.

i.c. Internal cutaneous nerve.

p. Phrenic nerve.

e.r. External respiratory nerve.

p.m. Twig to pectoral muscles.

PLATE II.—Fore Limb of the *CUSCUS MACULATUS.*

Fig. 1. Dissection of the pectoral muscles and of the side of the neck.

p^1. and p^2. The two parts of the pectoralis major.

p^3. Pectoralis minor.

p^4. Pectoralis quartus.

l.d. Latissimus dorsi.

p.c. Humeral portion of the panniculus carnosus.

d. Deltoid.

tr. Trapezius.

o.h. Omo-hyoid.

c.o. Cleido-occipital.

s.m. Sterno-mastoid.

c.m. Cleido-mastoid.

Fig. 2. Right manus—dorsal view—extensor tendons removed.

Fig. 3. Right manus—palmar aspect—dissection of the intrinsic muscles.

Figs. 2&3. d^1. First dorsal interosseus.
d^2. Second dorsal interosseus.
d^3. Third dorsal interosseus.
d^4. Fourth dorsal interosseous.
t. Fibrous slips connecting the tendons of the second and fourth dorsal interossei, with the heads of the adjacent metacarpal bones.
e. Abductor hallucis.
d. Abductor minimi digiti.
g^1. Flexor brevis pollicis.
g^2. Flexor brevis minimi digiti (outer head).
h. Adductor pollicis.
a. Adductor indicis.
b. Adductor annularis.
c. Adductor minimi digiti.
a.b. Fleshy fasciculus belonging to the palmar layer and connecting the bases of the index and annularis.
u.n. Ulnar nerve, dividing into superficial and deep branches.
d.n. Twig from the deep branch of the ulnar for the supply of the contiguous sides of minimus and annularis.
m.r.n. Medio-radial nerve.
d.b. Dorsal branch of medio-radial nerve.
u. Tendon of flexor carpi ulnaris.

Fig. 4. Dissection of the side of the chest, axilla, and upper arm of the *Cuscus*—left side.
p^4. Pectoralis quartus.
r.t. and $r.t^1$. Rectus thoracis.
p^3. Pectoralis minor.
p^1. and p^2. Pectoralis major.
s.c. Subclavius.
s.n. Nerve to subclavius.
cl. Clavicle.
c.d. Clavicular deltoid.
c. Coracoid process.
c.b.b. Coraco-brachialis brevis.
c.n. Circumflex nerve.
m.c.n. and $m.c.n^1$. The two parts of the musculo-cutaneous nerve.
l.d. Insertion of the latissimus dorsi.
m.s.n. Musculo-spiral nerve.
b. Biceps.
b.a. Brachialis anticus.

Fig. 4. *m.n.* Median nerve.
c.b.l. Coraco-brachialis longus.
a.i. Anconeous internus.
h. Humerus.
s.f. Supra-condyloid foramen, with the median nerve and humeral artery passing through it.
tr^3. Inner head of the triceps.
i.c.n. Internal cutaneous nerve.
d.e.n. Nerve to dorsi-epitrochlear muscle.
u.n. Ulnar nerve.
d.e. Dorsi-epitrochlear muscle.
t.m. Teres major.
p.c.n. Nerve to panniculus carnosus.
s.s. Subscapularis muscle.
b.p. Brachial plexus.
e.r.n. External respiratory nerve.
s. Scalenus medius.
l.d. Latissimus dorsi.
s.m. Serratus magnus.
o.e. External oblique muscle.

Fig. 5. Extensor aspect of the left forearm of the *Cuscus*.
e.d. Extensor communis digitorum.
r.l. Extensor digitorum secundus.
e.u. Extensor carpi ulnaris.
a.e. Anconeous externus.
e.p. Extensor secundi internodii pollicis.
e.p^1. and *e.p*^{2}. The two heads of origin of the extensor secundi internodii pollicis.
e.m. Extensor medii.
m.r. and *e.r.* Extensor ossis metacarpi pollicis.
e.b. Extensor carpi radialis brevior.
e.b^1.
e.b^2. } Its three heads of origin.
e.b^3.
e.l. Extensor carpi radialis longior.
s.l. Supinator longus.
m.s.n. Musculo-spiral nerve.

Fig. 6. Diagram of the brachial plexus of nerves in the *Cuscus*.
C.V. to C.VIII. The anterior primary divisions of the posterior four cervical spinal nerves.

Fig. 6. D. I. First dorsal nerve (anterior primary division).

s.c. Nerve to subclavius.
s. Suprascapular nerve.
s.s. Subscapular nerve.
c. Circumflex nerve.
m.s. Musculo-spiral.
m.c. Musculo-cutaneous nerves.
m. Median nerve.
u. Ulnar nerve.
i.c. Internal cutaneous nerve.
p.m. Nerve to pectoral muscles.
p.c. Nerve to panniculus carnosus.
p. Phrenic nerve.
e.r. External respiratory nerve.

PLATE III.—Hind Limb of the *CUSCUS*.

Fig. 1. Dissection of the gluteal region and the outer aspect of the thigh.

ec.g^1. } The two parts of the ecto-gluteus.
ec.g^2. }
ec.g.^{3} The agitator caudae.
ec.g^{1*}. Insertion of the anterior part of the ecto-gluteus.
ec.g^{2*}. Insertion of the posterior part of the ecto-gluteus.
ec.g^{3*}. Insertion of the agitator caudae.
p. Pyriformis.
p.n. Pudic nerve.
s.s.n. Small sciatic nerve (this nerve should be represented as passing under cover of *c.t.*).
g.n. Nerve supplying the gemelli, the quadratus femoris, and the adductor magnus.
h.n. Nerve to the hamstring muscles.
g. Gemelli muscles.
i.f. Ischio-femoral muscle.
c.t. Caudal portion of biceps.
o.e. Obturator externus.
Q.f. Quadratus femoris.
b. Biceps.
s.t. Semi-tendinosus.
a.m. Adductor magnus.

Fig. 1. *r.f.* Rectus femoris.
g.s.n. Great sciatic nerve.
v.e. Vastus externus.
s. Sartorius.
m.g. Meso-gluteus.
*m.g.** Insertion of meso-gluteus.
i. Iliacus.
en.g. Endo-gluteus.
s.g.n. Superior gluteal nerve.
c.i. Iliac crest.

Fig. 2. Inner aspect of the left leg of the *Cuscus*.
i.l.l. Internal lateral ligament of the knee-joint.
s.m. Semi-membranosus.
g. Gracilis.
s.t. Semi-tendinosus.
c.t. Caudal part of the biceps.
s. Slip from this to the semi-tendinosus.
t. Tibia.

Fig. 3. Ring digit of the foot of the *Cuscus*.
l. Lumbrical muscle.
f.p. Flexor profundus tendon.
f.s. Flexor sublimis tendon.

PLATE IV.—Hind Limb and Marsupium of *THYLACINUS*.

Fig. 1. Internal aspect of the thi
i.c.n. Internal cutaneous
a.m. Adductor magnus.
a.b. Adductor brevis.
v.i. Vastus internus.
r.f. Rectus femoris.
f.a. Femoral artery.
s. Sartorius.
a.c.n. Anterior crural ner
t.a. Transversalis abdomi
o.e. Obliquus externus.
o.i. Obliquus internus.
c. Cremaster.
g.c.n. Genito-crural nerve.

Fig. 1. *m.b.* Cartilaginous nodule representing the marsupial bone.
ps. Psoas.
i. Iliacus.
o.n. Obturator nerve.
g. Gracilis.
a.l. Pectineus.
s.m. Semi-membranosus.
b^2. Superficial caudal part of the biceps.
s.t. Semi-tendinosus.
b^1. Bicipiti accessorius (Haughton).
b. Biceps.
b^3. Tibial portion of the superficial caudal part of the biceps
Fig. 2. Dissection to show the gluteus quartus muscle in the Thylac
g.q. Gluteus quartus.
i. Iliacus.
v.i. Vastus internus.
v.e. Vastus externus.
$r.f^1$. Superficial head of rectus femoris.
s. Sartorius.
l. Dorsum ilii.
$r.f^2$. Reflected head of rectus femoris.
Fig. 3. Marsupial pouch of the female Thylacine.
Fig. 4. Dissection of the marsupial pouch of *Thylacinus*—teats left in position.
g.c.n. Genito-crural nerve.
c. Cremaster muscle.
s. Sphincter marsupii.
l.g. Lymphatic glands.
Fig. 5. Gluteal region and outer aspect of the thigh of *Thylacinus*.
h.n. Nerve to the hamstrings.
b^2. Superficial caudal part of the biceps.
s.s.n. Small sciatic nerve.
$ec.g^2$. Two portions of agitator caudae.
$ec.g^{2*}$. Insertion of agitator caudae.
b^1. Bicipiti accessorius (Haughton).
p.n. Pudic nerve.
g.n. Superior gluteal nerve.
$ec.g^1$. Ecto-gluteus.
$ec.g^{1*}$. Insertion of ecto-gluteus.
s.n. Branch from superior division of a sacral nerve.

Fig. 5. *m.g.* Meso-gluteus.
*m.g.** Insertion of the superficial part of the meso-gluteus.
en.g. Endo-gluteus.
i.f. Ischio-femoral muscle.
s. Sartorius.
r.f. Rectus femoris.
v.e. Vastus externus.
a.m. Adductor magnus.
b. Biceps.
s.t. Semi-tendinosus.
g'.s.n. Great sciatic nerve.

PLATE V.—Hind Limb of the *CUSCUS*, with a Diagram of the Sacral and Lumbar Plexuses of the *THYLACINE*.

Fig. 1. Right pes of the *Cuscus*.
Fig. 2. Dissection of the back of the leg of the *Cuscus*.
a. Soleo-gastrocnemius.
d. Large flexor muscle.
c. Plantaris.
b^1. Tendon of the inner head of the gastrocnemius.
a^1. Tendon of soleo-gastrocnemius.
e. Superficial flexor (flexor brevis digitorum).
k. Annular ligament.
t. Tibia.
g. Tibialis posticus externus.
f. and f^1. Tibialis posticus internus.
h. Semi-membranosus.
l. Internal lateral ligament of the knee-joint.
b. Inner head of gastrocnemius.
i. Femur.
1. External saphenous nerve.
2. Communicating branch from this to external plantar.
3. External plantar nerve.
4. Internal popliteal nerve.
5. Muscular branch from internal popliteal.
6. Internal plantar nerve.
7. Nerve to the hallux.
8. Twig from internal plantar to the superficial flexor.

Fig. 3. Anterior and outer aspects of the right leg of the *Cuscus*.

a^1. and a^2. The two heads of the peroneus longus.

c. Fibular head of extensor brevis digitorum for the minimus.

c'. Its tendon.

d. Fibular head of extensor brevis digitorum for the ring digit.

d'. Its tendon.

l^1. to l^4. Annular ligaments.

b. Peroneus brevis.

b'. Its tendon.

e. Extensor longus digitorum.

f. Tibialis anticus.

a'. Tendon of peroneus longus.

k^1. Abductor ossis metatarsi minimi digiti.

k^2. Abductor minimi digiti (inserted into the extensor tendon).

k^3. Abductor minimi digiti (inserted into sesamoid).

h. Pedal portion of extensor brevis digitorum.

g'. Tendon of extensor longus hallucis.

1. External popliteal nerve.

2. Anterior tibial nerve.

3. Musculo-cutaneous nerve.

Fig. 4. Posterior view of the right thigh of the *Cuscus* to show the adductor muscles.

t. Root of the tail.

a. Ischial tuberosity.

h. Obturator internus.

c. Quadratus femoris.

g'. Obturator externus.

b. Femur.

d. Adductor magnus.

e^1. Femoral opening in adductor brevis.

e. Adductor brevis.

f. Gracilis.

1. Obturator nerve.

Fig. 5. Diagram of the lumbar and sacral plexuses in the Thylacine.

Fig. 6. Diagram of the lumbo-sacral plexus in *Cuscus*.

I. L. to VI. L. The six anterior primary divisions of the lumbar nerves.

I. S. and II. S. Anterior primary divisions of the first and second sacral nerves.

g.c. Genitocrural nerve.

e.c. External cutaneous nerve.

Fig. 6. *s.* Twig to sartorius muscle.
a.c. Anterior crural nerve.
o. Obturator nerve.
s.g. Superior gluteal nerve.
g.m. Branch to gluteus maximus.
h. Nerve to hamstrings.
g'.s. Great sciatic nerve.
s.s. Small sciatic nerve.
p. Pudic nerve. (The twig marked "*p*" in fig. 6, which springs from the third lumbar nerve, goes to the psoas muscle.)

PLATE VI.—Dissections of the Feet of *THYLACINUS* and *CUSCUS*.

Fig. 1. Dissection of the intrinsic muscles of the left foot of the Thylacine. A probe has been introduced between the plantar layer of adductores and the intermediate layer of flexores breves.

*p*². Adductor indicis.
*p*⁴. Adductor annularis.
*p*⁵. Adductor minimi digiti.
} Plantar layer.

*f*².*o.* Outer head of flexor brevis indicis.
*f*².*i.* Inner head of flexor brevis indicis.
*f*⁵.*o.* Outer head of flexor brevis minimi digiti.
*f*⁵.*i.* Inner head of flexor brevis minimi digiti.
*d*². First dorsal interosseus.
*d*⁹. Abductor ossis metatarsi minimi digiti.
*d*⁹′. and *d*⁹″. The two abductors of the minimus.
1. External plantar nerve.
2. Deep division of external plantar nerve.
3 and 4. The two digital branches of the superficial division of the external plantar nerve.

Fig. 2. The same foot of the Thylacine. The plantar adductores have been thrown down, and a probe introduced between the intermediate flexores breves and the dorsal abductors.

The corresponding letters in fig. 1 indicate corresponding structures in this figure.

*f*². Flexor brevis indicis.
*f*³. Flexor brevis medii.
*f*⁴. Flexor brevis annularis.
*f*⁵. Flexor brevis minimi digiti.
} Intermediate layer.

Fig. 2. d^2. and $d^{2'}$. The two parts of the abductor indicis or first dorsal interosseus. } Dorsal layer.
d^3. Second dorsal interosseus. } Dorsal layer.
d^4. Third dorsal interosseus. } Dorsal layer.
d^5. Fourth dorsal interosseus. } Dorsal layer.
d^6. Abductor ossis metatarsi minimi digiti.
$d^{6'}$. Abductor minimi digiti (the part inserted into the extensor tendon).
$d^{6''}$. Abductor minimi digiti (the part inserted into the sesamoid bone).

Fig. 3. Diagram of the distribution of the cutaneous nerves on the dorsum of the left foot of *Thylacinus*.

1. Anterior tibial nerve.
2. Musculo-cutaneous nerve.
3. External saphenous nerve.

Fig. 4. Diagram of the cutaneous distribution of the plantar nerves in the left foot of the Thylacine.

1. External plantar nerve.
2. Internal plantar nerve.
3. Superficial division of the external plantar nerve.
4. Deep division of the external plantar nerve.

Fig. 5. Dissection of the intrinsic muscles of the right foot of the *Cuscus*. The plantar cartilage (*p.c.*) has been divided and the outer portion thrown outwards along with the opponens minimi digiti (op^5.).

p^1. Adductor hallucis.
r. Raphe.
p^4. Adductor annularis.
p^5. Adductor minimi digiti.
f^4. Flexor brevis hallucis.
f^5. Flexor brevis minimi digiti.
op^5. Opponens minimi digiti.
d^1. Abductor hallucis.
d^6, $d^{6'}$, $d^{6''}$. The three adductors of the minimus.
p.c. Plantar cartilage.
p.t. Plantaris tendon.

1. Nerve to hallux.
2. External plantar nerve.
3. Superficial division of the external plantar.
4. Deep division of external plantar.

Fig. 6. Right foot of the *Cuscus*. The adductores have been removed and the flexores breves thrown down so as to expose the dorsal abducting muscles.

p^1. Adductor hallucis.

f^2. to f^5. Flexores breves.

d^2. to d^5. Dorsal interossei.

d^4. Approximator of medius and annularis.

d^5. Approximator of the annularis and minimus.

d^x. Abducting slip of the third dorsal interosseus.

d^y. Abducting slip of the fourth dorsal interosseus.

d^3. Represents the deep part of the inner head of the flexor brevis medii artificially separated. It is supposed to represent the second dorsal interosseus.

ops. Opponens minimi digiti.

p.t. Peroneus longus tendon.

Fig. 7. Diagram of the cutaneous distribution of the plantar nerves in the right foot of the *Cuscus*.

1. Nerve to hallux.
2. Internal plantar nerve.
3. External plantar nerve.
4. Superficial division of external plantar nerve.
5. Deep division of external plantar nerve.
6. Communication between internal plantar nerve and the nerve to the hallux.

Fig. 8. Diagram of the cutaneous nerves on the dorsum of the right foot of the *Cuscus*.

1. External saphenous.
2. Musculo-cutaneous.
3. Long saphenous.
4. Dorsal twig from the nerve to the hallux.

PLATE VII.—The Feet of the *KOALA* and *VIRGINIAN OPOSSUM*.

Fig. 1. The right pes of the Koala.

Figs. 2 and 3. The same foot dissected so as to show the superficial and deep intrinsic muscles.

o.c. Os calcis.

l. Levator muscle of the heel.

c. Plantar cartilage forming the true heel.

p^1. Adductor hallucis.

p^2. and p^3. Adductor of the medius and index.

Figs. 2 and 3. p^5. Adductor of the minimus.
f^1. Flexor brevis hallucis.
f^2. Flexor brevis indicis.
f^3. Flexor brevis medii.
f^4. Flexor brevis annularis.
$f^5.t$. Tibial head of flexor brevis minimi digiti.
o.m. Opponens minimi digiti.
d^1. Abductor hallucis.
d^2. First dorsal interosseus.
d^5. Two parts of abductor minimi digiti.
a.m. Abductor ossis metatarsi minimi digiti.

Figs. 4 and 5. Superficial and deep dissections of the intrinsic muscles of the left foot of the Virginian Opossum.
p^1. Adductor hallucis.
p^2. Adductor indicis.
p^4. Adductor annularis.
p^5. Adductor minimi digiti.
f^1. to f^5. Flexores breves.
d^1. Abductor hallucis.
d^2. First dorsal interosseus.
$d^5.f$. and $d^5.t$. Two parts of the abductor minimi digiti.
a.m. Abductor ossis metatarsi minimi digiti.

PLATE VIII.—Intrinsic Muscles in the Feet of various Mammals.

Fig. 1. Left foot of the *Bathyergus capensis*.
f^1. to f^5. Flexores breves.

Fig. 2. Left foot of the otter.
p^1. Adductor hallucis.
p^2. Adductor indicis.
p^5. Adductor minimi digiti.
o.m. Opponens minimi digiti.
f^1. to f^5. Flexores breves.
$f^5.f$. Fibular head of flexor brevis minimi digiti.
$f^5.t$. Tibial head of flexor brevis minimi digiti.
d^2. to d^5. Dorsal interossei.
a.o. Abductor ossis metatarsi minimi digiti.

Fig. 3. Left foot of the Armadillo.

Fig. 3. p^1. Adductor hallucis.
p^2. Adductor indicis.
p^4. Adductor annularis.
p^5. Adductor minimi digiti.
$f^1.t.$ Tibial head of flexor brevis hallucis.
$f^1.f.$ Fibular head of flexor brevis minimi digiti.
f^5. Flexor brevis minimi digiti.
d^1. Abductor hallucis.
d^6. Abductor minimi digiti.
a.o. Abductor ossis metatarsi minimi digiti.
f.b. Fibrous bands.

Fig. 4. Dorsal aspect of the left pes of a dog to show the close apposition of the metatarsal bones.

Figs. 5 and 6. Dissections of the left pes of the Tamandua.
p^1. Adductor hallucis.
p^2. Adductor indicis.
p. Transversus indicis.
p^5. Adductor annularis.
f^1. to f^5. Flexores breves.
$f^5.t.$ Tibial head of flexor brevis minimi digiti.
$f^5.f.$ Fibular head of flexor brevis minimi digiti.
d^1. Abductor hallucis.
d^2. to d^5. Dorsal interossei.
d^6. Abductor minimi digiti.
a.o. Abductor ossis metatarsi minimi digiti.
e.p.n. External plantar nerve.

Fig. 7. Dorsal aspect of the left foot of the Leopard.
d^3. Second dorsal interosseus.
d^4. Third dorsal interosseus.
d^5. Fourth dorsal interosseus.

Fig. 8. The plantar aspect of the same foot.
p^2. Adductor indicis.
p^5. Adductor annularis.
o.m. Opponens minimi digiti.
d^2. to d^5. Dorsal interossei.
d^6. Abductor minimi digiti.
a.o. Adductor ossis metatarsi minimi digiti.
f^2. to f^5. Flexores breves.

PLATE IX.—The Thoracic Viscera of *THYLACINUS*, and the Feet of various Mammals.

Fig. 1. The heart and lungs of *Thylacinus*.

a. Subclavian vein (right).
b. Internal jugular vein (right).
c. Right subclavian artery.
d. Right common carotid artery.
e. Left common carotid artery.
f. Left subclavian artery.
g. Left internal jugular vein.
h. Left subclavian vein.
i. Superior intercostal vein.
n. Left anterior vena cava.
k. Posterior vena cava.
m. Right anterior vena cava.
l. Azygos vein.

Fig. 2. Dorsal aspect of the left foot of the Three-toed Sloth.

fl.br.d. Extensor brevis digitorum.
d^2. First dorsal interosseus.
d^3. Second dorsal interosseus.
d^4. Third dorsal interosseus.
d^5. Fourth dorsal interosseus.

Fig. 3. Palmar aspect of the left manus of the Three-toed Sloth.

2nd *p.i*. Second phalanx of the index.
2nd *p.m*. Second phalanx of the medius.
2nd *p.a*. Second phalanx of the annularis.
p^{2*}. Adductor indicis.
p^2. Transversus indicis.
p^4. Adductor annularis.
f^1. Flexor brevis pollicis.
$f^2.r$. Radial head of flexor brevis indicis.
f^4. Flexor brevis annularis.
f^5. Flexor brevis minimi digiti.
d.u.n. Deep division of the ulnar nerve.

Fig. 4. The same manus with the adductors reflected (drawn somewhat larger than nature).

$p.^2$ Transversus indicis.

Fig. 4. p^{2*}. Origin of adductor indicis.
$p^{4'}$. Insertion of adductor annularis.
p^{4*}. Origin of adductor annularis.
$f^2.r$. Radial head of flexor brevis indicis.
$f^2.u$. Ulnar head of flexor brevis indicis.
f^4. Flexor brevis annularis.
f^5. Flexor brevis minimi digiti (dragged inwards).
d^2. to d^5. Dorsal interossei.
$p^{2'}$. Insertion of adductor indicis.
h. Rudimentary hallux.
a. Rudimentary minimus.

Fig. 5. Diagram of the dorsal interossei of the left foot of the *Ornithorhynchus paradoxus*.
d^2. to d^5. Dorsal interossei.

Fig. 6. Plantar aspect of the left foot of the *Echidna setosa*.
p^1. Adductor hallucis.
p^2. Adductor indicis.
p^3. Adductor medii.
p^4. Adductor annularis.
$p^{4'}$. Additional slip of the adductor annularis.
p^5. Adductor minimi digiti.
f^1. Flexor brevis hallucis.
f^2. Flexor brevis indicis.
f^5. Flexor brevis minimi digiti.
f.d. Outermost belly of the flexor brevis digitorum.
d^1. Abductor hallucis.
d^3. Second dorsal interosseus.
e.p.n. External plantar nerve.

Fig. 7. Left foot of the horse—plantar aspect.
f^3. The suspensory ligament of the fetlock (flexor brevis medii)
d^3. Second dorsal interosseus.
d^4. Third dorsal interosseus.

PLATE X.—Abdominal and Pelvic Viscera of *THYLACINUS* and *CUSCUS*.

Fig. 1. A small portion of the upper part of the intestinal canal of the Thylacine to shew the long club-shaped villi.

Fig. 2. A small portion of the lower part of the intestinal canal of the Thylacine to show the short erect villi arranged in longitudinal rows.

Fig. 3. A portion of the lower part of the intestinal canal of the Thylacine turned inside out, and distended with spirit to show the large Peyer's patch (*p.*).

Fig. 4. A portion of the lower part of the intestinal canal of the Thylacine to show a small Peyer's patch (*p.*).

Fig. 5. Small intestine of a lion turned inside out to show the fleecy villi.

Fig. 6. Genito-urinary organs of the male Thylacine displayed by the removal of the sacrum.

a. Ureter.
b. Bladder.
c. Vas deferens.
d. Membranous portion of urethra.
e. Levator penis.
f. Crus penis.
g. Erector penis.
f.g. Crus penis, clothed by the erector penis.
h. and h^2. Cowper's glands enveloped in their muscular capsules.
i. Bulb of the penis enveloped by the bulbo-cavernosus muscle.
k. Retractor penis.
l. Penis.
m. Prostate.

Fig. 7. Bladder and prostatic urethra of the male Thylacine laid open (slightly enlarged).

c. Bladder.
a. Bristle in the ureter.
b. Bristle in the vas deferens.
d. Prostate.

Fig. 8. Genito-urinary organs of the male *Cuscus*.

a Kidney
c. Ureter.
d. Body of testicle.
e. Epididymis.
f. Crus penis clothed by erector penis.
g. Cowper's gland.
h. Bulb of penis clothed by bulbo-cavernosus.
i. Levator penis.
k. Prostate.
l. Retractor penis.
m. Bladder.

Fig. 9. Under surface of the penis of the *Cuscus* to show the levator penis.

a. Membranous urethra.

b. Cowper's gland.

c. Crus penis clothed by the erector penis.

d. Bulb of penis.

e. Levator penis.

Fig. 10. Bladder and prostatic urethra of the male *Cuscus* laid open.

a. Bladder.

b. Bristles in the ureters.

c. A bristle in the right vas differens (the opening of the left vas could not be found).

d. Prostate.

e. Crus penis.

Fig. 11. Anal glands of the *Cuscus*.

a. Rectum.

b, b^2, and b^3. Anal glands.

c. Penis.

PLATE XI.—Feet of the *FOX-BAT*, *WALRUS*, *ELEPHANT*, *DASYURE*, and *HARE*; also certain Figures illustrative of the Structure of the Suspensory Ligament in the Horse, Ox, and Sheep.

Fig. 1. Plantar aspect of the left foot of the fox-bat; adductors thrown down.

Fig. 2. Plantar aspect of the right foot of the same animal.

p^1. Adductor hallucis.

p^5. Adductor minimi digiti.

f^1. to f^5. Flexores breves.

d^v. Abductor ossis metatarsi minimi digiti.

e.p.n. External plantar nerve.

d.d. Deep division.

s.d. Superficial division.

i.p.n. Internal plantar nerve.

Fig 3. Plantar aspect of the left foot of a young walrus.

$p^1.o$. Adductor obliquus hallucis.

$p^1.t$. Adductor transversus hallucis.

p^5. Fibrous cord in the place of adductor minimi digiti.

f^1. to f^5. Flexores breves.

$f^1.t$. Tibial head of flexor brevis hallucis (?).

Fig. 3. $f.^1f.$ Fibular head of flexor brevis hallucis.
$d.^1$ Abductor hallucis.
$d.^4$ Third dorsal interosseus.
$d^{6'}$. Abductor ossis metatarsi minimi digiti.
d^6. Abductor minimi digiti.
d^{6*}. Accessory part of abductor minimi digiti.
e.p.n. External plantar nerve.
d. Deep division.
s. Superficial division.
i.p.n. Internal plantar nerve.

Fig. 4. Plantar aspect of the right foot of a fœtal elephant.
$p^2.t.$ Transversus indicis.
p^2. Fibrous cord representing adductor indicis.
f^2. to f^5. Flexores breves.
$f^5.t.$ Tibial head of flexor brevis minimi digiti.
d^6. Abductor minimi digiti.
e.p.n. External plantar nerve.
i.p.n. Internal plantar nerve.

Fig. 5. Plantar aspect of the left foot of *Dasyurus viverrinus*.

Fig. 6. Plantar aspect of the right foot of the same animal ; adductores removed.
p^1. Adductor hullucis.
p^2. Adductor indicis.
p^4. Adductor annularis.
p^5. Adductor minimi digiti.
r. Raphe.
f^1. to f^5. Flexores breves.
$f^1.t.$ Tibial head of flexor brevis hallucis.
$f^4.f.$ Fibular head of flexor brevis annularis.
d^2. to d^5. Dorsal interossei.
d^6, d^{6*}, and $d^{6'}$. The three separate parts of the abducting apparatus of the minimus.
e.p.n. External plantar nerve.
s. Superficial division.
d. Deep division.

Fig. 7*a*. Transverse section through the suspensory ligament of the fetlock of the horse
(*a*) Indicates the point in this section which is enlarged in fig. 7.

Fig. 7. The point "*a*" in fig. 7*a* as seen under a magnifying power of fifty diameters.
n. Nerve.
f. Adipose tissue.

Fig. 7. *m.* Muscular tissue.
t. Tendinous tissue.
v. Blood-vessels.

Fig. 8*a*. Transverse section through the suspensory ligament of the ox.
(*a*) Indicates the point in this section which is enlarged in fig. 8.

Fig. 8. The point "*a*" in fig. 8*a* as seen under a magnifying power of fifty diameters.
n. Nerves.
f. Adipose tissue.
m. Muscular tissue.
v. Blood-vessels.
t. Tendinous tissue.

Fig. 9*a*. Transverse section through the suspensory ligament of the sheep.
(*a*) Indicates the part which is enlarged in fig. 9.

Fig. 9. The point "*a*" in fig. 9*a* as seen under a magnifying power of fifty diameters.
t. Tendinous tissue.
f. Adipose tissue.
n. Nerve.
v. Blood-vessel.

PLATE XII.—Sternum and Vertebræ of the *THYLACINE*.

Fig. 1. Sternum of the female Thylacine, with portions of the ribs and the costal cartilages attached.
(*a*) First rib entire.

Fig. 2. Axis vertebra—left side. (*a*) Points to the layer of epiphysial cartilage which intervenes between the superior articular processes and the odontoid process on the one hand, and the body of the vertebra on the other.

Fig. 3. Cervical vertebra—from the middle of the series—right side.

Fig. 4. Dorsal vertebra—from the middle of the series—right side.

Fig. 5. Fourth lumbar vertebra—left side.

Fig. 6. Sacrum—dorsal view.

PLATE XIII.—Bones of the Fore and Hind Limbs of the *THYLACINE*.

Fig. 1. Right humerus—arrow directed through the supra-condyloid foramen

Fig. 2. Right radius.

Fig. 3. Right ulna.

Fig. 4. Right femur.
Fig. 5. Right fibula.
Fig. 6. Right tibia.
Fig. 7. The innominate bones of the female Thylacine—inferior aspect.
(a) The cartilaginous nodules, which represent the marsupial bones. They are apparently a direct continuation upwards of the cartilage which intervenes between the ossa innominata at the symphisis pubis.
(b) Ligament connecting the marsupial cartilage with the pectineal eminence.

In concluding this Report the author feels under heavy obligations to the gentlemen who have so faithfully delineated the various objects in the accompanying plates. More especially is he indebted in this respect to J. Dunlop Dunlop, M.B. (now in Adelaide, Australia), who has contributed eight plates, and to Arthur Thomson, M.B., Senior Demonstrator of Anatomy in the University of Edinburgh, who has executed two plates, and at the same time superintended the drawing of the Plates XII. and XIII. by Mr. T. Lauder Sawers. As already stated, the plate representing the feet of the Koala and the Virginian Opossum is the work of Alfred H. Young, F.R.C.S., of Manchester, and was drawn from his own dissections.

Fig. 3

Fig. 2

Fig. 1

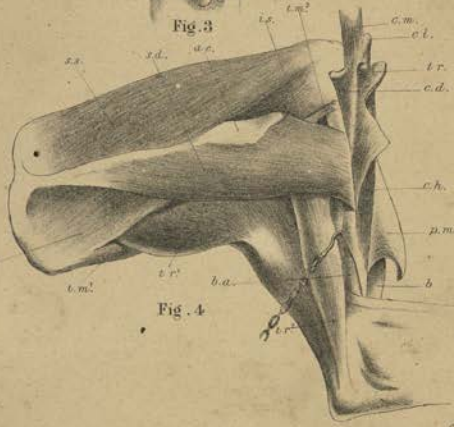


Fig. 4

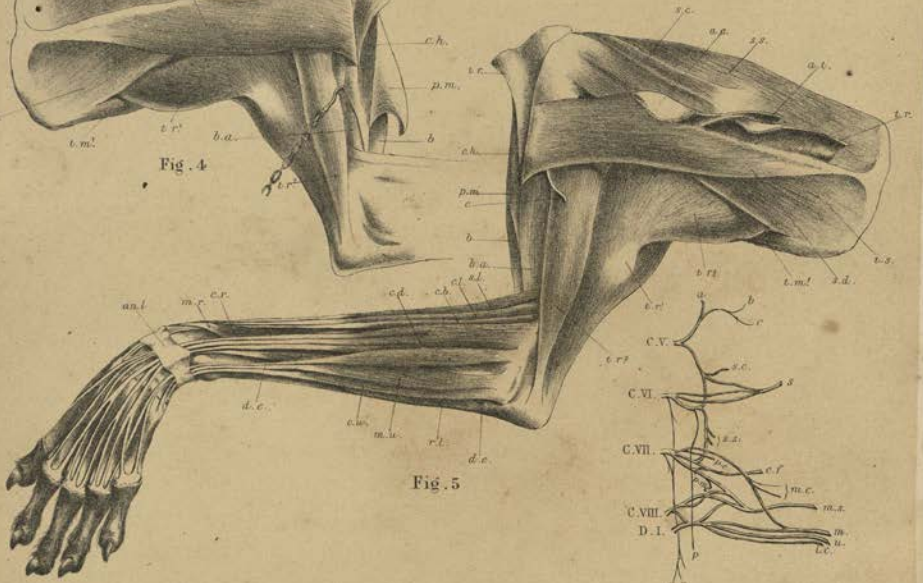


Fig. 5

J. Dunlop, Del.

W. & A. K. Johnston, Lithog.

THYLACINE

Fig. 1

Fig. 2

Fig. 3

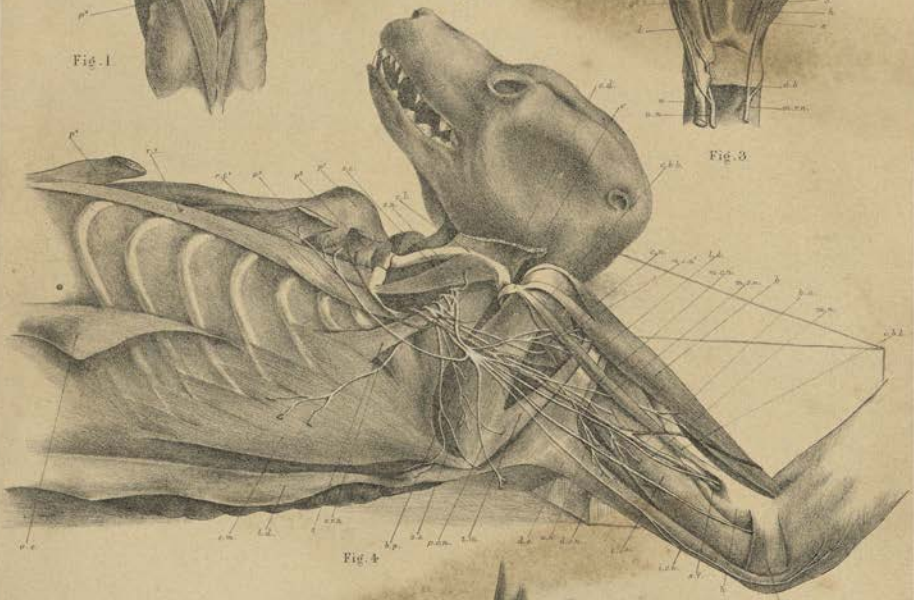
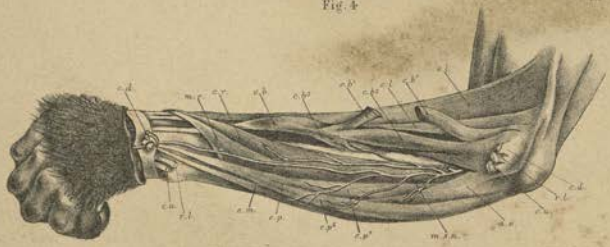


Fig. 4



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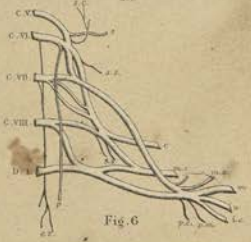

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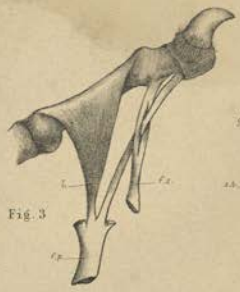

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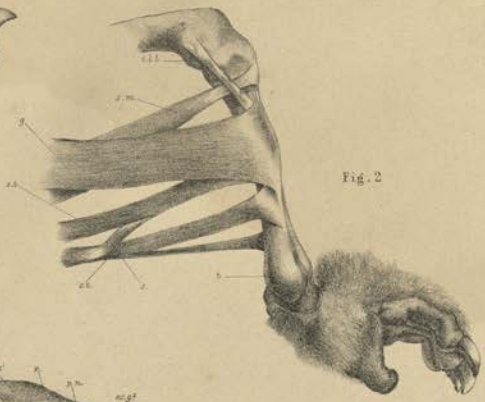

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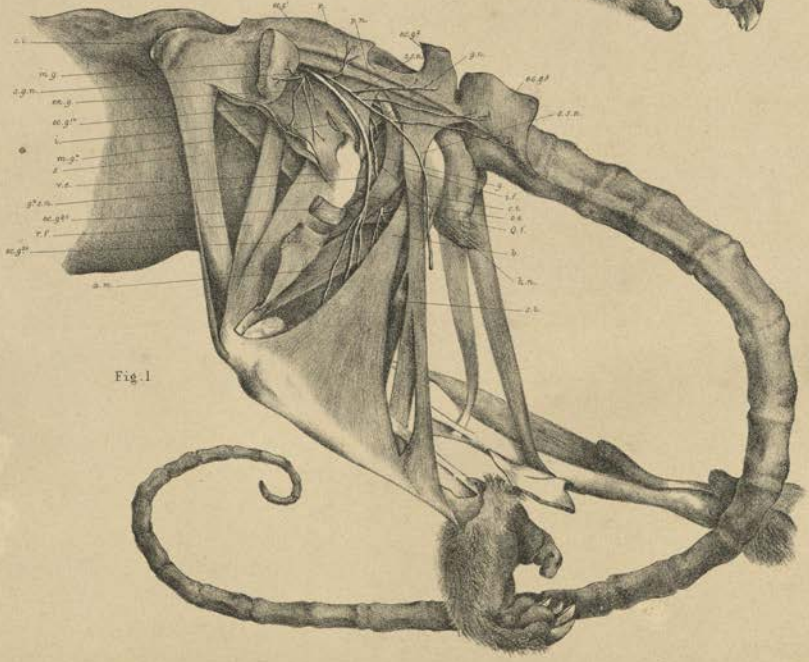
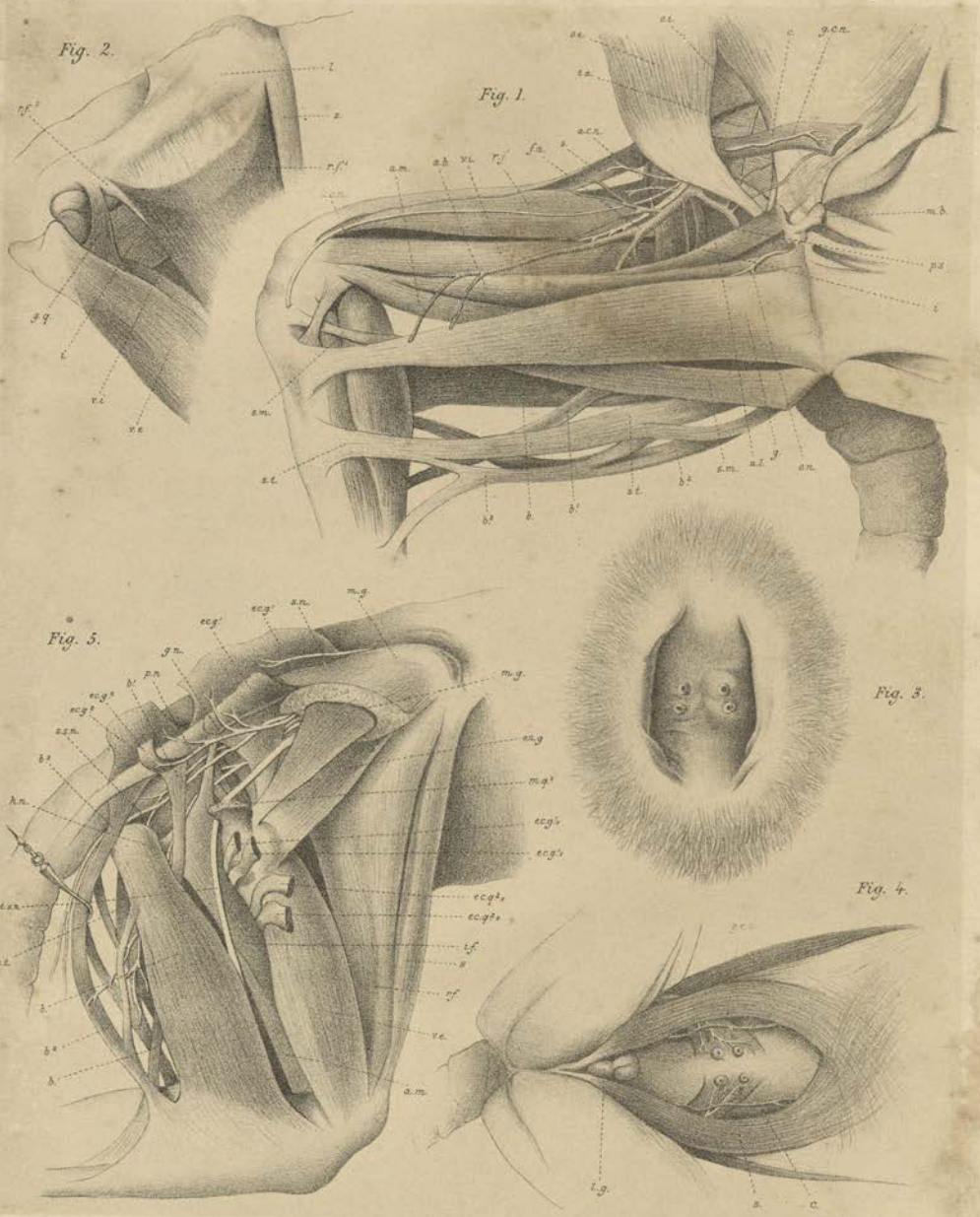


Fig. 1

J. Dunlop Dunlop, Del.

W. & A. Johnston, Lithographers.

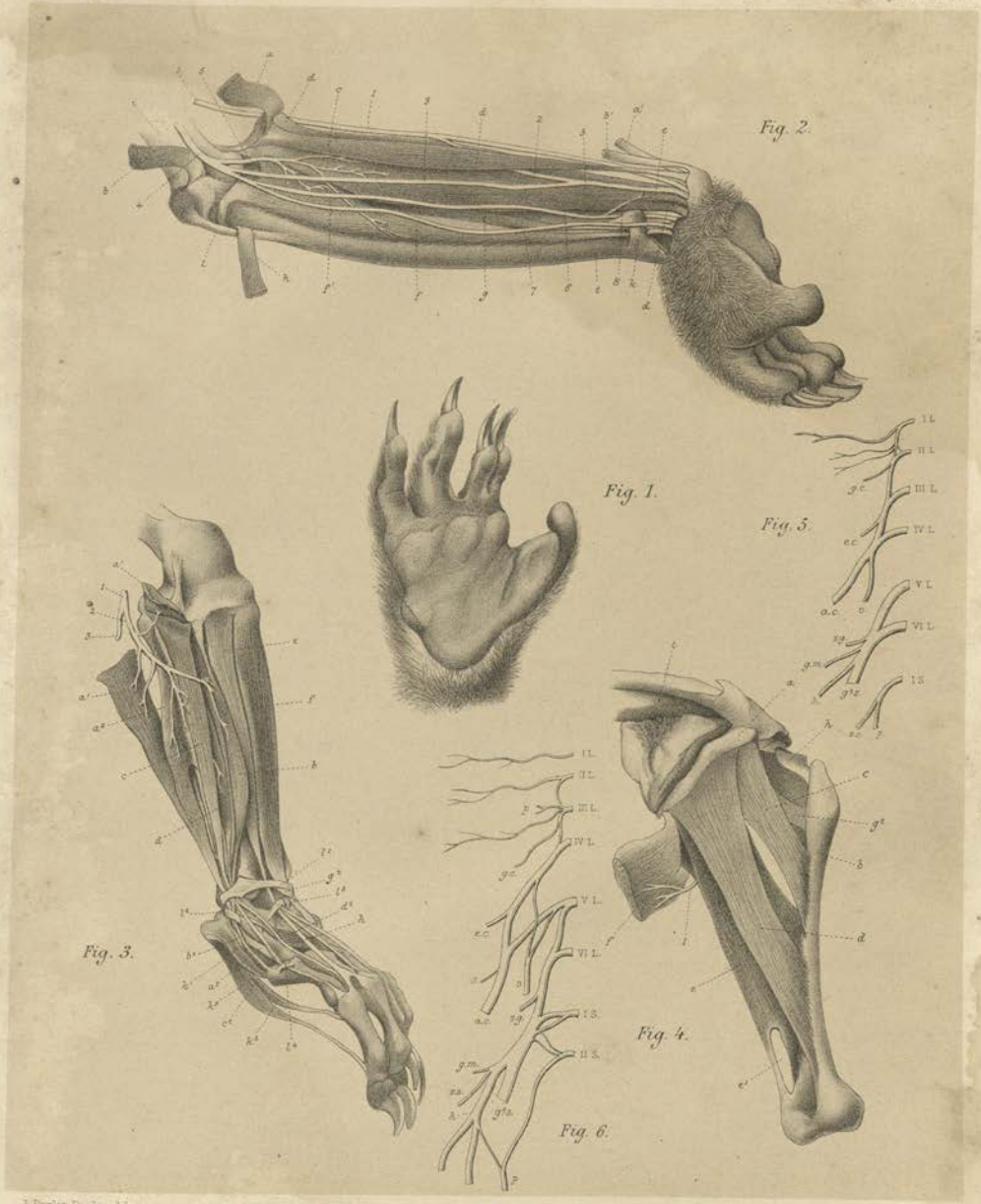
CUSCUS



J. Dunlop Dunlop, del.

F. Roth, Lith. Kissl.

THYLACINE.



J. Dunlop Dunlop, del.

F. Huth, Lith^r Edin^r

THYLACINE & CUSCUS.

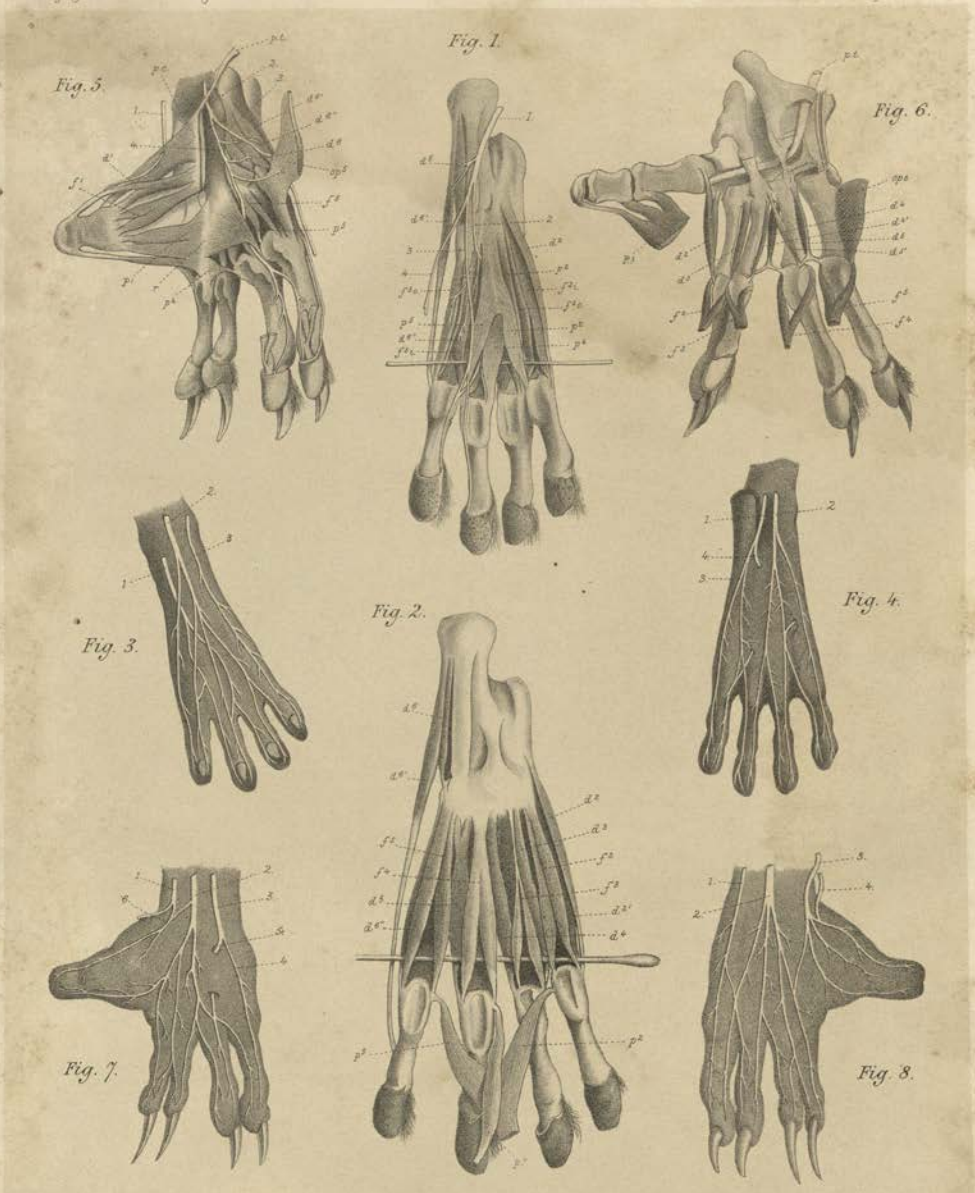


Fig. 1.
Fig. 2.
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Fig. 5.
Fig. 6.
Fig. 7.
Fig. 8.

Fig. 2.

Fig. 3.

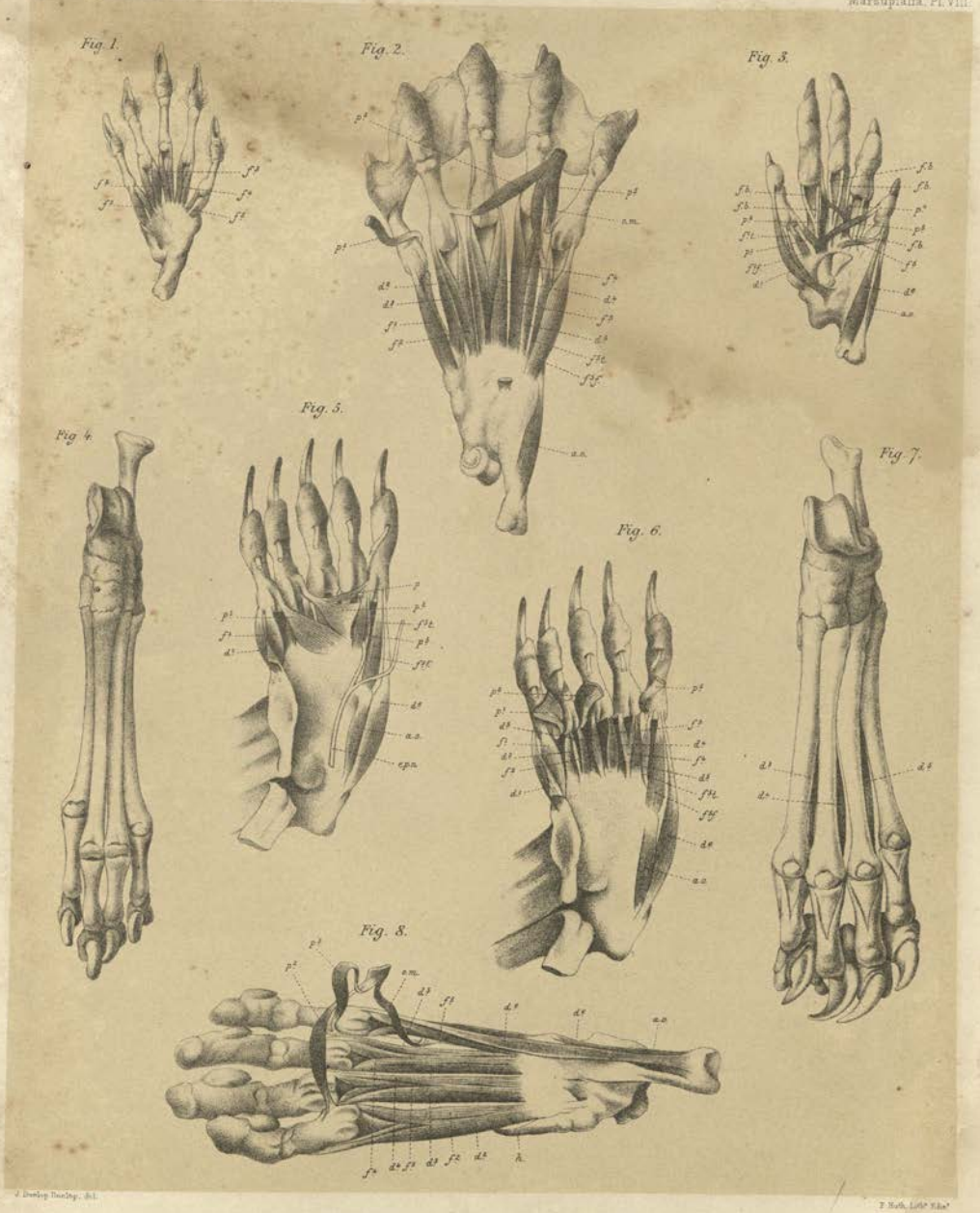
Fig. 1.

Fig. 4.

Fig. 5.

A. H. Young, del. F. Huth, Lith^r Edin^r

PHASCOLARCTOS CINEREUS. — DIDELPHYS VIRGINIANA.



FEET OF VARIOUS MAMMALS.

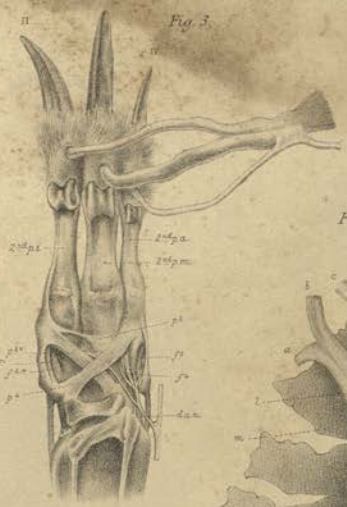


Fig. 3.

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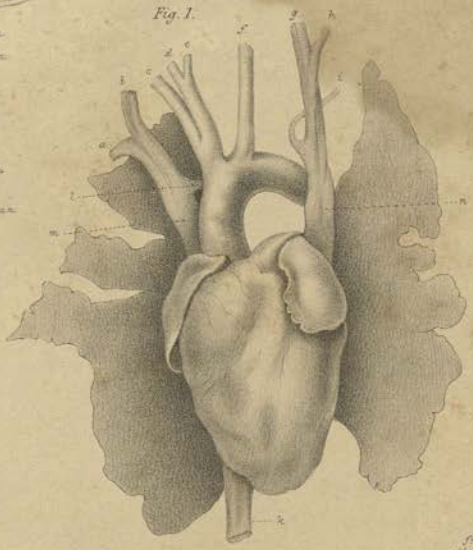


Fig. 1.

Fig. 7.

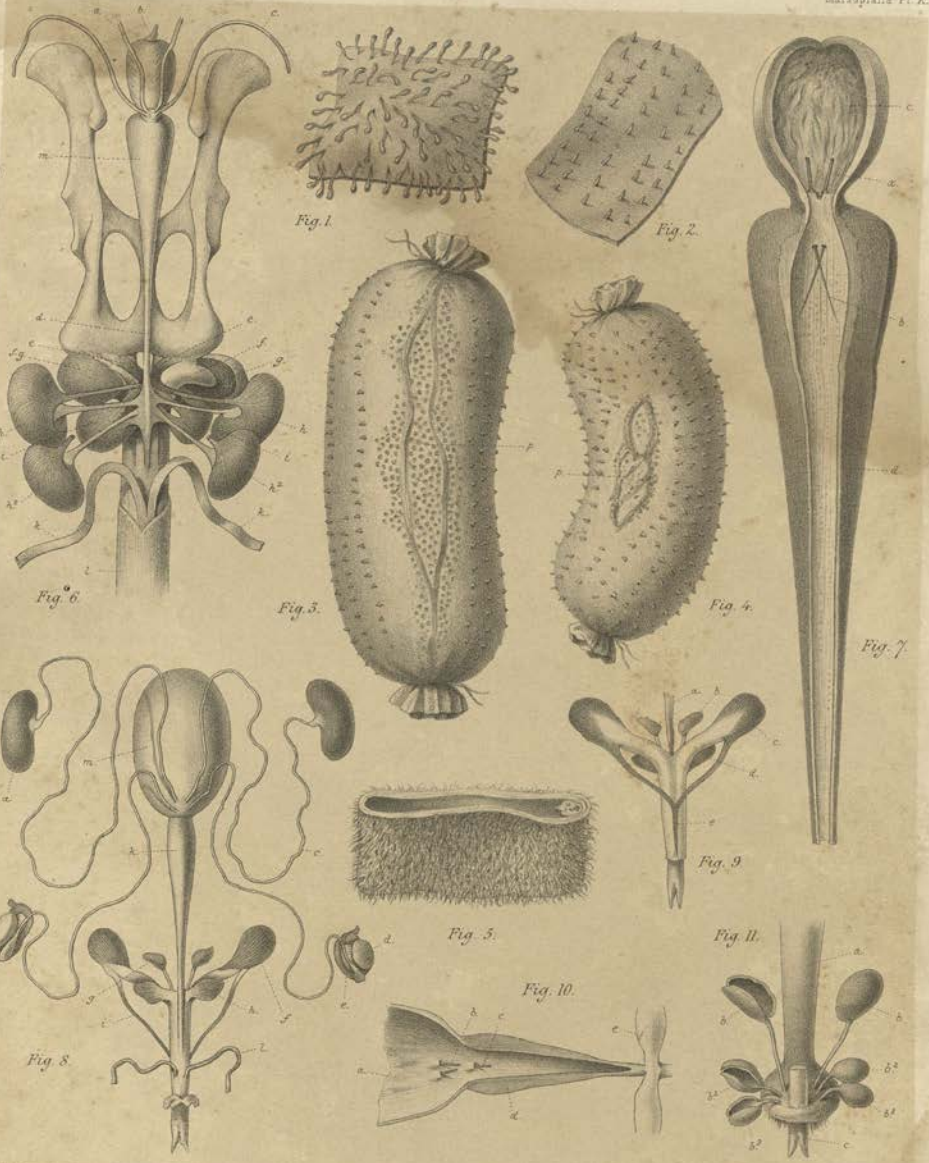
Fig. 4.

Fig. 6.

Arthur Thomson, M.B. del.

F. Huth, Lith. Edin.

FIG. 1, THORACIC VISCERA OF THYLACINE.—FIG. 2-7, FEET OF VARIOUS MAMMALS.



J. D. Dunlop, del.

F. Huth, Lith. Edin.

THYLACINE & CUSCUS.

Arthur Thomson, M.B. del. F. Huth, Lith^r Edin^r

FIG. 1-6, & FIG. 10, FEET OF VARIOUS MAMMALS.
FIG. 7-9, STRUCTURE OF SUSPENSORY LIGAMENT IN HORSE, OX & SHEEP.

Fig. 6.

Fig. 2.

Fig. 3.

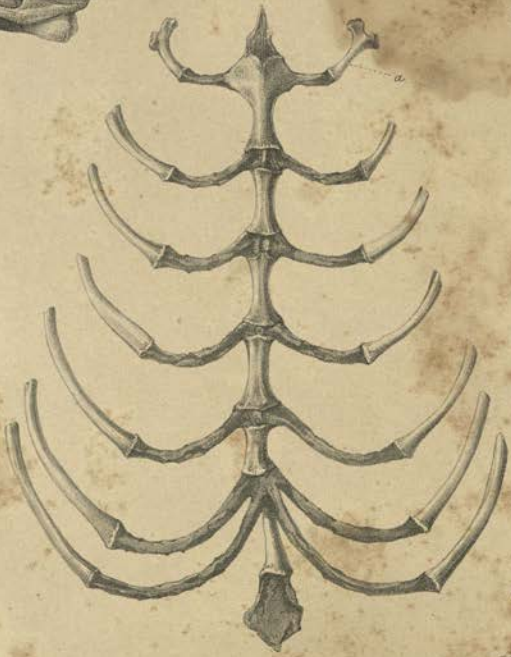
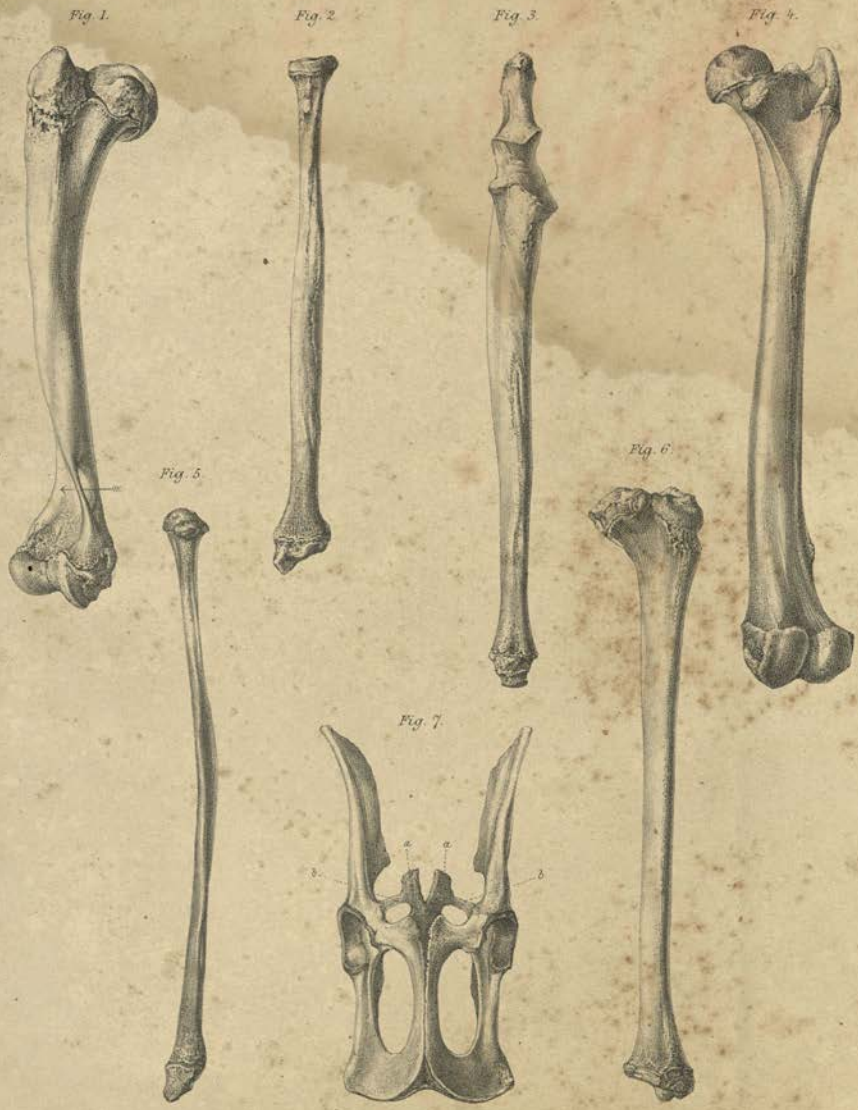


Fig. 4.

Fig. 5.

Fig. 1.



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THYLACINE.

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